PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XVIII. JANUARY TO MARCH, 1880. No. 105.

TABLE OF CONTENTS.

PAGE.

Stated Meeting, January 2..... 409

Stated Meeting, January 16..... 411

Stated Meeting, February 6..... 413

Stated Meeting, February 20..... 415

Stated Meeting, March 5..... 417

On the Oil sand of Bradford, McKean County. By *C. A. Ashburner*. (*With Plate VII.*)..... 419

Obituary notice of J. W. Harden. By *J. P. Lesley*..... 422

Astronomical approximations, II, III. By *P. E. Chase*..... 425

Relations of the Crystalline rocks of Pennsylvania to the Silurian limestones and the Hudson River age of the Hydromica schists. By *C. E. Hall*. (*With Plate VI.*)..... 435

An Account of an Old work on Cosmography. By *H. Phillips, Jr.*.. 443

On a New Synthesis of Saligenin. By *W. H. Greene, M.D.*..... 451

On the Foramina perforating the posterior part of the Squamosal bone of the Mammalia. By *E. D. Cope*..... 452

Biographical notice of Joseph Henry. By *Fairman Rogers*..... 461

The Timucua language. By *A. S. Gatschet*..... 465

A Mirror for Illuminating opaque objects for the Projecting Microscope. By *Persifor Frazer, Jr.*..... 503

Three methods and Forty-eight solutions of the Fifteen Problem. By *Persifor Frazer, Jr.*..... 505

Stated Meeting, January 2, 1880.

Present, 5 members.

President, Mr. FRALEY, in the Chair.

A letter accepting his appointment to prepare an obituary notice of the late M. Michel Chevalier, was received from Mr. Moncure Robinson, dated Dec. 22, 1879.

A letter of envoy was received from the London Meteorological office, dated Dec. 1879.

A letter requesting a copy of Proc. No. 100, to complete a set was received from the Central Austalt für Meteorologie, dated Vienna, Dec. 4, 1879.

A letter respecting exchanges of specimens was received from Mr. H. B. Dawson, dated Morisania, N. Y., Dec. 5, 1879.

Donations for the Library were received from the Prussian Academy; Revue Politique; London Astronomical, Geographical and Meteorological Societies, and the Cobden Club; the Royal Geological Society of Ireland; the Massachusetts Historical Society; the Boston Society of Natural History; the American Chemical Society; Mr. A. R. Grote; the Franklin Institute; American Journal of Mathematics; the North American Entomologist; the U. S. Treasury Department; the Botanical Gazette; the Ministerio de Fomento of Mexico, and Mr. S. H. Scudder.

A communication on the Velocity of Light, by P. E. Chase was read.

A paper entitled "An account of an old work on Cosmography, by Mr. Henry Phillips, Jr." was postponed to be read at the next meeting.

A paper on the relation of the crystalline rocks of Southeastern Pennsylvania to the Silurian limestones, and on the Hudson river age of the Hydromica schists (with map and specimens), by Mr. Charles E. Hall, of the Geological Survey, was postponed to be read at the next meeting.

PROC. AMER. PHILOS. SOC. XVIII. 105. 3A. PRINTED MARCH 30, 1880.

The report of the judges and clerks of the annual election for officers of the Society was read, and the following named persons were declared duly elected to be the officers for the ensuing year:

President.

Frederick Fraley.

Vice-Presidents.

Eli K. Price, E. Otis Kendall, J. L. LeConte.

Secretaries.

P. E. Chase, G. F. Barker, J. P. Lesley, D. G. Brinton.

Councillors for three years.

R. E. Rogers, Robert Bridges, Oswald Seidensticker, Richard Wood.

Curators.

Hector Tyndale, C. M. Cresson, Henry Phillips, Jr.

Treasurer.

J. Sergeant Price.

Pending nominations Nos. 885 to 892 were read.

Mr. Lesley was nominated for Librarian for the ensuing year.

And the meeting was adjourned.

Stated Meeting, January 16, 1880.

Present, 16 members.

President, Mr. FRALEY, in the Chair.

A letter of acknowledgment was received from the R. Academia dei Lincei, Dec. 16, 1879 (102, 103).

Letters of envoy were received from the U. S. Department of the Interior, Jan. 2; the U. S. Naval Observatory, Jan. 16; and Dr. B. A. Gould, Director of the Argentine Observatory at Cordova, S. A.

Donations for the Library were received from the Geological Survey of Japan; the Russian Academy; the Zoologischer Anzeiger; M. Delesse, and the Revue Politique of Paris; London Nature; the Museum of Comparative Zoölogy at Cambridge; the Canadian Naturalist; Harvard Observatory; Silliman's Journal; the Scientific American; the Numismatic Society; the Journal of Pharmacy; the Cincinnati Natural History Society; the Botanical Gazette; the Bureau of Education; the Geological Survey of the Territories; the Fish Commissioners; the Department of the Interior; General Wheeler; and the Mexican Meteorological Bureau.

The death of Dr. Jacob Bigelow, at Boston, Jan. 10, 1879, aged 92, was reported.

Mr. Phillips read an elaborate description of his latin copy of the curious Cosmography of Sebastian Munster, who was born 1489, and died at Basle, *circa* 1552.

Mr. Hall exhibited his provisionally colored map of south-eastern Pennsylvania, from Trenton westward to and across the Susquehanna River, and discussed the age of the Philadelphia rocks on his hypothesis of their metamorphism, considering them Silurian, and perhaps in part Devonian.

Mr. Rand, Prof. Frazer and Mr. Lesley took part in the

discussion, the last two dissenting from the view held by Mr. Hall.

A communication was made by Dr. Greene "On a New Synthesis of *Saligenin*."

Mr. Lesley was elected Librarian for the ensuing year.

The President appointed the Standing Committees as follows:—

On Finance.

Mr. Eli K. Price,
Mr. B. V. Marsh,
Mr. Henry Winsor.

On Publication.

Dr. John L. LeConte,
Dr. D. G. Brinton,
Dr. G. H. Horn,
Prof. E. Thomson,
Dr. C. M. Cresson.

On the Hall.

Gen. H. Tyndale,
Mr. S. W. Roberts,
Mr. J. S. Price.

On the Library.

Mr. Eli K. Price,
Rev. C. T. Krauth,
Mr. Henry Phillips, Jr.,
Dr. R. S. Kenderdine,
Prof. E. J. Houston.

Pending nominations Nos. 885 to 892 were read, spoken to, and ballotted for, and on scrutiny of the ballot boxes by

the President, the following persons were declared duly elected members of the Society :—

Cav. Damiano Muoni, of Milan.
Mr. Charles Francis Adams, of Boston.
Mr. Henry Wharton, of Philadelphia.
Mr. Charles A. Ashburner, of Philadelphia.
Mr. Robert C. Winthrop, of Boston.
Mr. Archibald Geikie, of Edinburgh.
Dr. Oliver Wendell Holmes, of Boston.
Mr. George Whitney, of Philadelphia.

And the meeting was adjourned.

Stated Meeting, February 6, 1880.

Present, 14 members.

President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from Robert C. Winthrop, 90 Marlborough Street, Boston, January 23; Henry Wharton, 2011 Delancey Place, Philadelphia, January 19; Charles A. Ashburner, 9 Woodland Terrace, West Philadelphia, January 28; Charles Francis Adams, Boston, January 22; and Oliver Wendell Holmes, M. D., Boston, January 23.

Letters of acknowledgment and postal cards (Proc. 104), were received from many correspondents and members.

Letters of envoy were received from the London Meteorological Office, December, 1879, and the Royal Society of New South Wales, December 18, 1879.

Letters were received from Prof. S. F. Baird and Miss Mary A. Henry, respecting Prof. Henry's library.

A letter was received from Mr. J. G. Henderson, Win-

chester, Scott Co., Ill., January 6, respecting mound skulls.

Donations to the Library were received from the Asiatic Society of Japan; the Academies at Berlin and Brussels; the Ludwig Salvator Museum, at Dresden; the Geographical Society and School of Mines, at Paris; the Geographical Commercial Society, at Bordeaux; the R. Astronomical Society and Meteorological Society, in London; the Rev. S. S. Lewis of Cambridge, England; the Museum of Comparative Zoology in Cambridge, Mass.; the Boston Society of Natural History; the American Journal of Science and Arts in New Haven; Prof. W. Carrington Bolton; the Historical Society and American Chemical Society, of New York; the Poughkeepsie Society of Natural History; the Pennsylvania Historical Society; the Franklin Institute; the American Journal of Pharmacy; the American Journal of the Medical Sciences and Medical News; Mr. Henry Phillips, Jr.; and Dr. B. A. Gould, Director of the Observatory at Cordova, South America.

The death of the Hon. Adolph E. Borie, at Philadelphia, on the 5th instant, aged 70, was announced by Mr. Price.

The death of the Rev. Dr. Rudder, at Philadelphia, on the 29th ultimo, aged 58, was announced by Mr. Price.

Prof. Cope exhibited suites of skulls of extinct mammalia (allied to canis, felis and ursus), obtained in the Tertiary deposits on the Pacific Coast, and described their order of evolution. Among them was the skull of a large cave-bear.

He then read a paper "On the Foramina perforating the posterior part of the Squamosal bone of the Mammalia."

New nominations Nos. 893, 894, 895 were read.

Mr. Fraley reported the receipt of the last quarterly interest on the Michaux Legacy, due Jan. 1, amounting to $132.

On motion of Mr. Phillips it was

"*Resolved*, That whereas the Society was incorporated on the 15th day of March, 1780, a fact on which the late Mr. Robert M. Patterson laid

great stress in his address before the Society in 1843, as having given 'to this Society for the first time a legal position which it now occupies,' and

"*Whereas*, The 15th day of March, 1880, will mark the hundredth anniversary of such incorporation, therefore be it

"*Resolved*, That the Board of Officers and members in Council be respectfully requested to make suitable arrangements for celebrating this anniversary."

And the meeting was adjourned.

Stated Meeting, February 20, 1880.

Present, 17 members.

President, Mr. FRALEY, in the Chair.

A letter accepting his appointment to prepare a eulogy on Dr. Wood, was received from Dr. Henry Hartshorne, dated on the 9th instant.

A letter of envoy from the Harvard College Observatory was received, dated Jan. 29.

An acknowledgment of the receipt of Proceedings, No. 104, was received from Prof. Wm. P. Blake.

A circular letter of invitation to send delegates to the Centennial Anniversary of the American Academy of Arts and Sciences, on the 26th of May next, in Boston, Mass., was read and its consideration postponed to the next meeting.

A circular letter of invitation to attend the celebration of the two-hundredth anniversary of the discovery of the Falls of St. Anthony, at 10 o'clock, A. M., on the 3d day of July, 1880, on the University Campus, Minneapolis, Minne-

sota, was read and its consideration postponed to the next meeting.

A circular letter was received from the late Chief of the Statistical Bureau of Sweden, Herr Fr. Th. Berg, and another from his successor, Herr Elis Sidenbladh, desiring a continuance of correspondence.

Donations to the Library were received from the Swedish Bureau of Statistics; the Academia dei Lincei; the Revue Politique; the Bordeaux Geographical Society; London Nature; the American Academy, and Boston Society of Natural History; the Hon. G. C. Winthrop; the Harvard Observatory; the North American Entomologist; the Franklin Institute; the Medical News; the Smithsonian Institution; the U. S. Naval Observatory; the Light House Board; the Department of the Interior, the Cincinnati Society of Natural History, and the Revista Scientifica.

An obituary notice of the late Joseph Henry was read by Mr. Fairman Rogers.

The death of Mr. James Lenox, in New York, on the 18th inst., aged 80, was announced by the Secretary.

The death of Dr. John Neill, in Philadelphia, on the 12th inst., aged 60, was announced by Mr. Price. On motion, Dr. Brinton was appointed to prepare an obituary notice of the deceased.

Dr. König communicated facts respecting his discovery of *Spinel* and *Chondronite* in the crystalline limestone of Chester county, Pennsylvania, and exhibited specimens, comparing them with specimens from Orange county, N. Y., and explaining their analogy with the minerals of Franklin, N. J.

Dr. Brinton communicated a memoir on the Timucua language of Florida, by Albert S. Gatschet, and gave a verbal summary of its contents, manner and value. This is the third important study of this group of languages, the other two having been already published in the Proceedings of the Society.

Prof. Frazer explained by diagrams his new arrangement, by a side-hinged mirror, for illuminating intensely the whole field of the object under a microscope. A strong side light is reflected at a low angle from the *under* surface of a glass plate placed across the front of the objective, on to and again from the side mirror suspended from hinges, on to the object, and so back through the tube to the eye of the observer.

The minutes of the last meeting of the Board of Officers and Council were read.

Pending nominations Nos. 893, 894, 895, and new nominations Nos. 896, 897 were read.

And the meeting was adjourned.

Stated Meeting, March 5, 1880.

Present, 17 members.

President, Mr. FRALEY, in the Chair.

A letter accepting membership was received from Mr. Archibald Geikie, dated Geological Survey Office, Edinburgh, Feb. 2.

Letters of acknowledgment were received from the Natural History Society, Emden, dated Nov. 15 (102); the Royal Society of Luxembourg, dated Aug. 20 (102); the Société Hollandaise, dated Harlem, Sept 20 (102, 103); and the Surgeon General's Office, at Washington, dated Feb. 20 (104).

Letters of envoy were received from the Trigonometrical

Survey of India, dated Dehra Dun, Jan. 20; the Natural History Society, dated Emden, Nov. 15; the Royal Saxon Society, dated Leipsig, Oct. 25; the Imperial Academy, dated Vienna, Dec. 1; the Société Hollandaise, dated Harlem, Dec.; the U. S. Naval Observatory, and Department of the Interior, dated Washington, Feb. 19.

A letter respecting Dr. Gabb's memoir was received from Mr. R. S. Swords, acting Librarian of the New Jersey Historical Society, dated Newark, March 3.

Donations for the Library were received from the Mining Bureau at Victoria; the Repertorium für Meteorologie at St. Petersburg; the Academies at Berlin, Vienna, Rome, and Brussels; the Societies at Moscow, Stuttgardt, Halle, Giessen, Emden, Bordeaux, Liège, and Harlem; the Swedish Bureau of Statistics; the German Geological Society at Berlin; the Geological Association at Dresden; the Revue Politique; the Grand Ducal Institute at Luxembourg; the Minister of the Interior at Brussels; the London Astronomical, Geographical and Meteorological Societies; Society of Arts, and London Nature; the Essex Institute; the New York Academy of Sciences; the Brooklyn Entomological Society; the North American Entomologist; Dr. Wm. Elder; Mr. W. B. Taylor; the U. S. Department of the Interior; the Army Bureau; the Journal of Pharmacy, at Philadelphia; the Cincinnati Observatory; the St. Louis Public School Library; the Kansas Historical Society; and the San Francisco Mercantile Library Association.

An obituary notice of the late John W. Harden was read by Mr. Lesley.

The death of Gen'l Clement A. Finley, in West Philadelphia, September, 1879, was announced by the Secretary.

On motion the committee on the paper of X. Y. Z. for the Magellanic premium, was entrusted with the care of the document for examination, to report.

Mr. Ashburner exhibited specimens and photographs of Oil Sands, and read a paper on the constitution of the Brad-

ford Oil Sand of McKean county, Pennsylvania. Remarks were made by Dr. Rogers and Mr. Lesley.

Prof. Frazer exhibited his microscopic reflector, made by Mr. Zentmeyer.

Mr. Frazer then discussed the principles of the problem of the popular 15 number-puzzle with Mr. Briggs.

Pending nominations Nos. 893 to 897, and new nominations Nos. 898 to 901 were read.

On motion, the subject (postponed from the last meeting) of appointing delegates to assist at the Centennial Anniversary of the American Academy of Science and Art, at Boston, was referred to the President, Mr. Fraley, with power to act.

And the meeting was adjourned.

On the Constitution of the Bradford Oil Sand. By Chas. A. Ashburner, M.S., Asst. Second Geological Survey of Pennsylvania. (With a plate.)

(*Read before the American Philosophical Society, March* 5, 1880.)

The constitution of the petroleum sands of Western Pennsylvania, which were discovered in Venango county twenty-one years ago, and which have ever since been producing mineral oil, is no doubt familiar to most of our geologists. The question suggests itself; in what way is the Bradford sand of McKean county, Pennsylvania, and Cattaraugus county, New York, dissimilar?

Before describing the structure of the sands, permit me to give some general facts showing the relative per centage of *dry holes* and the out-put of the *producing wells* in the two districts. At a glance, the comparison will indicate that some essential differences must exist in the sands and mode of occurrence of the oil, to account for the different results which have been obtained.

During the year 1879, there were 475 wells drilled to the Venango oil

sands in the counties of Warren, Venango, Clarion and Butler; of this number 122 were *dry holes* or produced no oil; being 25.7 per cent.

In the Bradford or Northern district, there were during the same year, 2536 wells drilled to the Bradford oil sand, of which number but 76 were *dry holes* or only 3 per cent.; being nearly 23 per cent. less than in the Venango or Western district.

The average daily production, for the first month, of the wells drilled in the Bradford sand was about 20 barrels, while for the wells in the Venango sands it did not attain that amount.* When we take these facts into consideration, we can readily understand why there should have been 2536 wells drilled in the Northern district to only 475 in the Western.

Since the beginning of the year 1875, when the Bradford oil horizon was discovered, there have been 6249 wells drilled in the district, of which 236 were dry holes or 3.77 per cent. From the most authentic statistics which I can gather in the Western district, about one-fourth of all the wells which have been drilled in the Venango sands, since their discovery in 1859, have proved dry.

The Bradford sand consists of a gray and white sand, of about the same coarseness as the ordinary beach sand of the Jersey coast; compact, yet loosely cemented. The average thickness of the sand is about 45 feet, and from top to bottom, the sandy strata change but little in their general character. It is only when specimens from the successive layers are placed side by side and closely examined, that any difference in structure can be recognized. The grains of sand are angular, vary but slightly in size, color and the quantity of cementing material which holds them together in their rock bed.

The same homogeneousness, which characterizes the vertical section, is found to exist over a considerable horizontal area. In fact but little change is found to exist in the sand obtained from wells 15 miles apart, or in the sand from the intermediate wells.

The greatest length of the Bradford district is 18 miles north, 30° east; its greatest width is 12 miles in a north and south direction. The area of the territory is between 100 and 110 square miles. In this area the sand is so regular and constant that if wells were drilled at random the number of dry holes, which would be obtained, would hardly exceed 2 in every 100. The percentage of dry holes spoken of as being obtained in the district includes those which were drilled outside of the *probable oil territory* and were genuine *wild-cat wells*.

In the Western district the characteristics of the Venango sands are quite different. The third or bottom sand, which is the most productive of the

* Some of the wells drilled to the Venango third oil sand have produced from 2000 to 3000 barrels of oil per day, while the largest well ever found in the Bradford district has not exceeded as many hundred. The largest individual wells have been located in the Western district; the largest average wells in the Northern district.

group, is sometimes thin, very fine, micaceous and muddy when taken from the sand pump; in this condition it seldom produces any petroleum. This is the character of the sand at Pleasantville, where it contained only a trace of oil. The black oil of this district came from what was known as the stray or split third, occurring some 25 feet above the regular sand. Where the Venango sands are formed in thin layers, fine grained and clayey the driller views the territory with suspicion.

NOTE.—It must be remembered in comparing the sands of the two districts that they belong to different geologic formations. Based on lithological and stratigraphical facts, I make the Venango oil sand group the equivalent of the Red Catskill, No. IX (Old Red Sandstone), while the Bradford sand is of Chemung age.

The following general section shows their relative positions:

Venango group, Catskill, No. IX.	First sand	40 feet.
	Interval	105 "
	Second sand	25 "
	Interval	110 "
	Third sand	35 "
Chemung, No. VIII.	Interval	1000±
	Bradford sand	45′ "

See "Oil Sands of Penna.," Franklin Institute Journal, April 1878, also "Bradford Oil District," Transactions American Institute Mining Engineers, Vol. VII; by the Author.

The accompanying illustration shows a typical specimen of a good producing third sand in the Venango group and a specimen of Bradford sand, such as might be taken from any of the producing wells in the Northern district. A productive Venango sand consists of a white, gray or yellow pebble rock; the pebbles being loosely cemented together and generally bedded in fine sand. The rock is open and porous. The interstices between the pebbles and sand grains are extensive and capable of containing a large bulk of oil; but this character does not maintain itself over any extended area. Areas of such sand are small and scattered and are separated by sand beds, possessing a character belonging to the unproductive sands.

The Venango sands are not homogeneous over any considerable area and are frequently very heterogeneous in section. The thickness of the sand varies; in one locality the upper part of the sand may be pebbly and of productive character and the lower part fine and contain no oil, while but a short distance away the conditions may be reversed.

Such then are the principal features of the two great oil producing rocks of Pennsylvania.

Résumé. The Bradford sand is fine but porous; constant in thickness; homogeneous in section; the character of the sections remaining the same over a very wide area.

The Venango sands are sometimes coarse, pebbly and porous, and sometimes fine, compact and clayey; variable in thickness; heterogeneous in section and subject to sudden changes in very short distances.

The difference in the structure of the sands, when considered in connection with their relative productiveness, is a strong argument in support of the view which has been accepted by the *best informed* of our geologists that the sands are only reservoirs or sponges which serve to hold the oil, coming almost entirely from an inferior formation to which it is indigenous.

The conditions under which these two sands were deposited must have been essentially different. The Venango sands were undoubtedly shore and shallow water deposits. The currents, by which the sediments forming the group were transported, were evidently rapid and shifting. It has been suggested that the sands may have been laid down in a river bed. This would necessitate dry land at the time, on either side of the territory where the sands are at present found.

The Bradford sand was possibly deposited in deeper water, by a slower and more constant current. It does not bear any evidences of being a shore deposit, but was probably formed in a bay or estuary.

An Obituary Notice of the Late John W. Harden. By J. P. Lesley.

(*Read before the American Philosophical Society, March* 5, 1880.)

John W. Harden was born at Leicester, England, June 19th, 1816, and died at Philadelphia, November 8th, 1879.

He was versed in the arts of Horticulture and Floriculture, and for a number of years followed them professionally. Was especially successful in designing, ornamenting and laying out estates, notably those of Hon. Capt. Cust, Wormleybury, Hertfordshire and Sir Ralph Howard, Bart., Craven Cottage on the Thames.

He commenced practice as a Mining Engineer in 1846, and in that year took the management of the Hawkesbury Colliery, near Coventry, England. He was the means of introducing into the Warwickshire coal field most of the modern improvements at that time only in use at the best collieries in the North of England. Wire ropes took the place of hemp ropes

and chains, guides and carriages were introduced, high speed direct acting hoisting engines replacing the slow, geared machine of the condensing type. These improvements required corresponding facilities, and extended operations underground, so that much larger areas of mineral were by these means won through one shaft.

He left this colliery in 1857 for the purpose of sinking the New Shafts for the Exhall Coal Company, for winning the coal and ironstone underlying the Blakeslee estate, to the dip of the Hawkesbury Colliery. He succeeded in passing the waterbearing strata and reaching coal, although a former attempt by others had failed. He here met with an accident from which it was thought he could not recover. In descending the shaft he was caught between the carriage and surface plate; receiving injuries about the head and face which disfigured him, and no doubt shortened his life many years. After his recovery he made a professional trip to this country, from which he derived so much benefit that he determined to settle in America, and did so in 1865, and for a time had charge of the Anthracite Mines of the Plymouth Coal Company, in Luzerne county, Pennsylvania.

In 1866, he with his sons, established and maintained a large professional practice in Wilkesbarre until 1870, when he removed to Philadelphia, continuing practice until physical disability confined him to the house. His last report was made in August, 1874, for the Cameron Coal Company. He retained all his faculties, and continued to give advice up to within two weeks of his death.

He was married three times, and leaves a widow and two children, besides four grown sons by his first marriages.

He was a member of the North of England Institute of Mining and Mechanical Engineers, the American Philosophical Society, and the American Institute of Mining Engineers.

My acquaintance with Mr. Harden commenced on board the Liverpool steamer in the autumn of 1863. I was going to make a special investigation of the alleged success of a new process for hardening the heads of rails, which led me on to an examination of the Bessemer experiments in various parts of Europe; and he was returning from the journey to which I have already alluded.

His face was disfigured by the terrible injuries it had received; but that could not conceal the dignity and amiability which was natural to it. He was attractive in all respects, and I soon found the utmost satisfaction in our intercourse. Sir Henry Holland was our constant companion in our walks on deck, and it would be hard to say which of the two, unlike as they were, inspired one with more pleasure.

No one could long know Mr. Harden without loving him and confiding in him. His judgments of men's motives were kind; his criticisms of their acts tempered by justice and guided by a long experience; his opinions were liberal and manly; his business decisions were gravely and

concisely expressed, after a close and systematic statement of all the facts of the case after personal examination. He impressed every one with the feeling that they were dealing with a man who professed to know only certain things, and to know these because he had used or made opportunities for learning them well, before he spoke of them. His uprightness was so evidently ingrained that it seemed to hold no relations with either an educated sense of duty, public opinion, or business interests; and the perfect straightforwardness with which he treated everything and everybody gave to his carriage and demeanor the air of nobility.

These traits of character with which I could not help being greatly impressed during our voyage, and which merely made me at that time look upon my companion of a week as one of the finest specimens of man I would be likely to encounter, became in after years the basis of a warm friendship between us.

In the following year I was called upon to designate the Superintendent of an extensive colliery near Wilkesbarre, to equip which it was necessary to make both sinkings and buildings, lay railways and throw a large bridge across the Susquehanna river. I was fortunate enough to induce Mr. Harden to accept the responsible position, and he took this opportunity to settle with his sons in America. Had his accident of 1863 not implanted the seeds of paralysis in his brain, we should not now be lamenting the long sufferings and death of a remarkable man; for, during a number of years he acquired a reputation among our coal and iron men, which would have placed him foremost among professional experts of Mining Engineering in Pennsylvania.

His physical energy and endurance so well supported his intellectual ability; his long experience was so completely at the command of a good judgment; the warmth of his heart colored so charmingly his inflexible and proud integrity; while natural force of will and earnestness of purpose made his executive plans rapid and direct, and his methods so thoroughgoing as to be the reverse of that penny-wise pound-foolish, hand to mouth manner so common with Americans,—that life alone failed to the establishment of his fame among us.

Such was the man whose name stands worthily on the list of members of our Society.

Astronomical Approximations. II, III. By Pliny Earle Chase, LL.D., *Professor of Philosophy in Haverford College.*

(*Read before the American Philosophical Society, Jan.* 2, 1880.)

II. Velocity of Light, and Kirkwood's Analogy.

The cosmical undulations should produce effects at every centre of inertial reaction, which would furnish data for approximate determinations of the velocity of light. We have seen that the favorable central position of the Earth, in the belt of greatest condensation, leads to a simple equation for Sun's apparent diameter and, therefore, for finding the quotient of Earth's distance from Sun by Sun's semi-diameter. The accuracy of the result is confirmed by other inferences which may be drawn from the same data.

Kirkwood's Analogy may be formulated thus:

$$\left(\frac{\rho_n}{\rho_0}\right)^3 \times \left(\frac{\nu_0}{\nu_n}\right)^2 = \text{a constant} \ldots\ldots\ldots\ldots\ldots\ldots (1.)$$

Let ρ_0 denote Sun's semi-diameter; ρ_1, ρ_2, etc., the mean vector-radii of the several planets (Mercury$_1$, Venus$_2$, etc.); μ, mass; t, time of rotation synchronous with revolution at Laplace's limit; ν_n, number of rotations in ν_0 orbital revolutions synchronous with primitive solar rotation; v_λ, velocity of light; v_n, velocity of revolution $(\sqrt{gr})$ at the surface of planet$_n$; r, planetary radius; the subscript figures being applicable to μ, t, ν, v, and r. The actions and reactions of light-waves, between the nucleal centre (Sun) and the principal centre of primitive condensation (Earth), lead to the equation, similar to Kirkwood's:

$$\left(\frac{\rho_n}{\rho_0}\right)^3 \times \left(\frac{\nu_0}{\nu_n}\right)^2 = \left(\frac{v_n}{v_\lambda}\right)^2 \frac{\mu_0^2}{\mu_n \mu_3} \times \left(\frac{t_n}{t_3}\right)^2 \frac{r_n}{r_3} \ldots\ldots\ldots (2.)$$

For Earth, $\rho_n = \rho_3 = 214.54\rho_0$; $\nu_n = \nu_3 = 366.256\nu_0$; $v_n = v_3 = .0012383r_3$; $v_\lambda = 214.54\rho_0 \div 497.83 = .43096\rho_0$. Substituting, and taking the square root of equation (2), we get:

$$\frac{214.54^{\frac{3}{2}}}{366.256} = \frac{.0012383r_3}{.43096\rho_0} \times \frac{\mu_0}{\mu_3} \ldots\ldots\ldots\ldots\ldots\ldots (3.)$$

If we designate density by δ, mass varies as $r^3\delta$, or as the square of $\frac{r}{v}$. Therefore $\frac{\delta_3}{\delta_0} = \left(\frac{r_0}{g_0} \div \frac{r_3}{g_3}\right) = \left(\frac{1 \text{ year}}{214.54^{\frac{3}{2}}} \div 5074 \text{ sec.}\right)^2 = 3.9175.$

Substituting in (3), dividing and reducing:

$$\left.\begin{aligned} &\frac{214.54^{\frac{3}{2}}}{366.256} \times \frac{.43096}{.0012383} \times 3.9175 = \left(\frac{\rho_0}{r_3}\right)^2 \\ &108.155 r_3 = \rho_0 = 428{,}600 \text{ miles.} \\ &\rho_3 = 214.54 \rho_0 = 91{,}950{,}000 \text{ miles.} \\ &v_{\lambda} = \rho_2 \div 497.83 = 184{,}710 \text{ miles.} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (4.)$$

If we suppose Sun to contract till Laplace's limit would correspond with Sun's present equatorial radius, the foregoing equations would all be deducible from the following:

$$\left.\begin{aligned} &\frac{\mu_3 t_3}{\mu_0 t_0} = \frac{v_3}{v_{\lambda}} \\ &\frac{\mu_3}{\mu_0} \times \frac{1 \text{ dy}}{.11624 \text{ dy}} = \frac{4.907}{184{,}710} \\ &\mu_0 = 323{,}350 \mu_3 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (5.)$$

In these first approximations no allowance has been made for orbital eccentricities, or for disturbances by the principal planets. I am, therefore, inclined to attach more importance to the following methods.

The equivalence of luminous action and reaction, between the nucleal centre (c_0) and the principal centre of primitive condensation (c_3), is shown by Earth's still retaining one-half of the original rupturing force. According to Stockwell, Earth's mean eccentricity is .0338676. If the rupturing locus is represented by mean perihelion, since the superficial velocity of rotation in a condensing nebula varies inversely as radius, the rupturing velocity was $\frac{1}{.9661324}$ times the mean velocity. The constant solar equation $\frac{g_0 t_0}{2} = v_{\lambda}$, would be satisfied in .9661324 × ½ yr., if we look only to solar gravity at the corresponding nucleal surface, or in .9661324 yr., if we look to initial terrestrial gravity as one-half of corresponding solar gravity.

$$\left.\begin{aligned} &v_{\lambda} = .9661324 \times 365.256 \times 86400 \times \frac{32.0874}{5280} = 185{,}287 \text{ miles.} \\ &\rho_3 = 497.83 v_{\lambda} = 92{,}242{,}000 \text{ miles.} \end{aligned}\right\} \quad (6.)$$

In equation (4), if we substitute Earth's mean solar day for the sidereal day, we get:

$$\rho_0 = \left(\frac{366.256}{365.256}\right)^{\frac{1}{2}} \times 428{,}600 = 429{,}200 \text{ miles.}$$

$$\left.\begin{aligned} &\rho_3 = 92{,}070{,}000 \text{ miles.} \\ &v_{\lambda} = 184{,}970 \text{ miles.} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (7.)$$

By the well-known laws of elasticity, M, the solar *modulus* of light, or the height of a homogeneous æthereal atmosphere, at Sun's surface, which

would transmit undulations with the velocity of light, is $\left(\frac{v_\lambda}{v_0}\right)^2 \rho_0$. This is equivalent to $\left(\frac{.43096}{.00062563}\right)^2 \rho_0 = 474{,}500\rho_0$. For v_λ, as we have already seen, is $.43096\rho_0$, and v_0 is $\frac{2\pi\rho_3 \times (214.54)^{\frac{1}{2}}}{365.256 \times 86400} \times \frac{214.54\rho_0}{\rho_3} = .00062563\rho_0$. If the cyclical variations of alternately increasing and diminishing stress, to which every particle of the Sun is exposed during each half-rotation, are due to the velocity of light, the equations, $\frac{g_0 t_0}{2} = v_\lambda$, and $\sqrt{g_0 \rho_0} = .0006\text{-}2563\rho_0$, give:

$$\left.\begin{aligned} g_0 &= .00000039142\rho_0 \\ t_0 &= \frac{2 \times .43096\rho_0}{g_0} = 2{,}202{,}050 \text{ sec.} = 25.486 \text{ dy.} \end{aligned}\right\} \quad \ldots\ldots(8.)$$

The continual disturbances at Sun's surface, and the combined influences to rotation and revolution upon spots near the solar equator, make it impossible to find the exact value of t_0 by direct observation. Laplace's estimate was 25½ days; Carrington's 25.38 days. According to his observations, "near the equator the period was about 25.3 days, while it was a day longer in 30° latitude. Moreover, the period of rotation seems to be different at different times, and to vary with the frequency of the spots. But the laws of these variations are not yet established. In consequence of their existence, we cannot fix any definite time of rotation for the Sun, as we can for the Earth and for some of the planets. It varies at different times, and under different circumstances, from 25 to 26½ days." *

It is, therefore, impossible now to assign any more probable value to t_0 than the one which I have deduced theoretically from the stress of luminous waves. If future observations should lead to the acceptance of a period which is either slightly less or slightly greater, the discrepancy can be easily accounted for, either by orbital acceleration or by inertial resistance and retardation.

If ρ_a represents Stockwell's determination of the centre of the belt of greatest condensation ($1.016878\rho_3 = 218.16\rho_0$) and if we suppose a similarity of action and reaction at the nucleal centre (Sun's centre $= c_0$) and at the dense-belt centre (c_a), we find:

$$\left.\begin{aligned} &\left(\frac{M}{\rho_0}\right)^{\frac{1}{2}} \times \left(\frac{\rho_a}{\rho_0}\right)^{\frac{1}{2}} = \frac{1 \text{ yr.}}{1 \text{ dy.}} \times \frac{g_0}{g_3} \\ &(474500 \times 1.016878 \times 214.54)^{\frac{1}{2}} = 366.256\frac{g_0}{g_3} \\ &g_0 = 27.78 g_3. \\ &\rho_0 = \frac{g_0}{g_3}\frac{\delta_3}{\delta_0} r_3 = 27.783 \times .9175 \times 3962.8 = 431{,}250 \text{ miles.} \\ &\rho_3 = 214.54\rho_0 = 92{,}520{,}000 \text{ miles.} \\ &v_\lambda = 185{,}850 \text{ miles.} \end{aligned}\right\} \quad \ldots(9.)$$

*Newcomb: *Popular Astronomy*, p. 250.

The influence of luminous undulation is also shown by the principal planet of the light belt (Jupiter), which is also the controlling planet of the system. For the time required by light, to traverse the linear orbit ($4\rho_5$) which would be synchronous with Jupiter's orbit, is equivalent to the time of satellite revolution at Jupiter's surface $\left(2\pi\sqrt{\frac{r_5}{g_5}}\right)$.

$$4 \times 5.2028 \times 497.829 = 10360.24 = 2\pi\sqrt{\frac{r_5}{g_5}}$$

$$\frac{\delta_0}{\delta_5} = \left(\frac{10360}{10043}\right)^2 = 1.0642$$

$$\frac{r_0}{r_5} = (1047.875 \div 1.0642)^{\frac{1}{3}} = 9.9485$$

$$\frac{g_0}{g_5} = 1047.875 \div (9.9485)^2 = 10.587.$$

$$\frac{\nu_5}{\nu_0} = 11.86 \times 365.256 \times 24^h \div 9^h\,55^m\,26^s.5^* = 10477.56.$$

$$\frac{v_\lambda}{v_5} = (10.587 \times 9.9485)^{\frac{1}{2}} \times 688.84 = 7069.5$$

$$\frac{t_3}{t_5} = 24^h \div 9^h\,55^m\,26^s.5 = 2.4183.$$

(10.)

Substituting in (2); $(5.2028 \times 214.54)^3 \div (10477.56)^2 = \frac{1047.88}{7069.5^2} \times \left(\frac{1}{2.4183}\right)^2 \times \frac{\mu_0 r_5}{\mu_3 r_3}$

Multiplying by $\frac{r_0}{r_5} = 9.9485$, and reducing; $137718750 = \left(\frac{r_0}{r_3}\right)^4$

$\rho_0 = 108.33 r_3 = 429{,}300$ miles.

$\rho_3 = 214.54 \rho_0 = 92{,}100{,}000$ miles.

$v_\lambda = .43096 \rho_0 = 185{,}000$ miles.

The experiments which are now in progress, for measuring the velocity of light, may lend interest to the following comparative tabulation, in kilometers, of some of the most important approximations to the velocity.

By Measurement.			
Maxwell	(Electricity),	288,000	kil.
Ayrton and Perry	"	298,000	"
Foucault,		298,360	"
Michelson,		299,820	"
Cornu,		300,000	"
By the Nebular Hypothesis.			
From Kirkwood's Analogy,		(4) 297,254	kil.
"	"	(7) 297,672	"
" Jupiter's density,		(10) 297,720	"
" Earth's mean perihelion		(6) 298,182	"
" Primitive condensation		(9) 299,088	"

*This is the time of Jupiter's rotation, as given by Professor Asaph Hall.

All the elements for the foregoing calculations can be measured with much greater accuracy than the solar parallax, the position of the moon's centre, cometary disturbance, or any other similar astronomical data. The identification of luminous and electro-magnetic action, by Weber, Kohlrausch, Thomson, Maxwell, and Perry and Ayrton, together with Peirce's investigations of the influence of repulsive force in the miniature world-building of cometary nuclei,* lead me to hope that further research will show what modifications are needed in order to secure exact astronomical measurements, by means of the equal action and reaction of opposing forces.

III. Controlling Centres.

The principal centre of gravity in the solar system (Jupiter–Sun), is at $5.2028 \times 214.54\rho_0 \div 1047.88 = 1.06522\rho_0$. The ratio of synchronous lineal and circular orbits $= \frac{2}{\pi}$. The wave-velocity which counteracts Earth's semi-diurnal variations of stress, is $v_{\beta} = \frac{32.08 \times 43082}{5280} = 261.76$ miles. Equating radial (numerator) and tangential (denominator) influences, we find :

$$\left.\begin{aligned} &\frac{v_\lambda}{v_\beta} = \frac{2}{\pi} \times \frac{1.065\mu_0}{\mu_5} \\ &v_\lambda = 186{,}025 \text{ miles.} \\ &\mu_5 = 92{,}606{,}000 \text{ miles.} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (1.)$$

At any given distance from cosmical centres the orbital influence is proportioned to the mass. Hence the equation :

$$\left.\begin{aligned} &\frac{v_\lambda}{v_\beta} \times \frac{v_5}{v_3} = \frac{\mu_5}{\mu_3} \\ &\frac{186{,}025}{261.76} \times \sqrt{\frac{1}{5.2028}} = 311.56 \\ &\frac{\mu_0}{\mu_3} = 311.56 \times 1047.88 = 326{,}500 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (2.)$$

A similar reciprocity, introducing some further interesting considerations, may be found by looking to the centre of reciprocal nebular rupture, Neptune's secular perihelion. Adopting Stockwell's value of Neptune's greatest eccentricity (.0145066), and taking the mean between Stockwell's (30.03386) and Newcomb's (30.05437) estimates of Neptune's mean radius-vector, Neptune's secular perihelion (ω) is at $3\pi^2\rho_3$. Both the linear centre of oscillation and the collisions of subsiding particles† tend to produce cosmi-

*Trans. Amer. Acad., 1859.

†*Ante*, xvii, 100.

cal aggregations at $\frac{2}{3}r$. This tendency, considering ω as a centre, would fix the boundary of the belt of retrogradely rotating planets at $\frac{1}{3}\omega = \pi^2\rho_3 = 9.8695\rho_3$, or between Saturn's mean and aphelion positions, so that Saturn well represents the surface of the belt of directly rotating planets. When the rotating wave-velocity (w) was operating in Saturn's orbit $\left(\text{at } \frac{\omega}{3}\right)$ the orbital velocity $\left(\frac{w}{\pi}\right)$ was found at $\left(\frac{\omega}{3\pi} = \pi\right)\rho_3$, or in the asteroidal belt (3.142), nearly midway between the mean perihelion of Mars (1.403), and the secular perihelion of Jupiter (4.886), and also nearly midway between Earth's secular aphelion (1.068), and Jupiter's mean distance (5.203), as well as between the mean aphelia of Venus (.774), and Jupiter (5.519). The next change of wave-rotating to orbital velocity brings us to Earth, the central and greatest mass in the belt of greatest condensation. If we start from 2ω, the surface of early subsidence which would give orbital velocity at ω, all these relations may be embodied in the equation:

$$\left.\begin{aligned} \left(\frac{v_\lambda\, w_3}{g_0\sqrt{r_0\, r_3}}\right)^2 &= 6\pi^2 \\ \left(\frac{688.84}{16.982}\right)^2 \times \frac{g_3}{g_0} &= 59.217 \\ 27.785 g_3 &= g_0 \end{aligned}\right\} \quad \ldots\ldots\ldots(3.)$$

By Eq. II., (9); $\rho_3 = 92{,}540{,}000$ miles.

$\mu_0 = 329{,}200\mu_3$

The action and reaction between the reciprocal centre (Neptune) and the centre of condensation (Earth), are also shown in the ratio between v_3 and the velocity of terrestrial rotation (w_3):

$$\left.\begin{aligned} \frac{v_3}{w_3} &= \frac{4.907}{.289} = 16.982 \\ \frac{\mu_3}{\mu_8} &= \frac{w_3}{v_3} \\ \frac{\mu_0}{\mu_8} &= \frac{329{,}200}{16.982} = 19{,}385 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots(4.)$$

Newcomb's estimate for $\frac{\mu_0}{\mu_8}$, as deduced from observations on Neptune's satellite, is $19{,}380 \pm 70$. By combining (4) with Eq. (11) in "Further Confirmations of Prediction," * we find the equation between moments of reciprocal rotation $\left(\frac{\mu}{\rho^2}\right)$ and times of synchronous rotation and revolution $\left(2\pi\sqrt{\frac{r}{g}}\right)$:

* Ib. xviii, 231.

$$\left.\begin{aligned} \frac{\mu^3\,\rho_s^{\,2}}{\mu_s\,\rho_3^{\,2}} &= \frac{\mu_0\,t_3}{\mu_3\,t_0} \\ \frac{19{,}385\rho_s^{\,2}}{329{,}200\rho_3^{\,2}} &= \frac{329200 \times 5074 \text{ sec.}}{1 \times 31558150 \text{ sec.}} \\ \rho_s &= 29.9936\rho_3 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (5.)$$

The Saturnian orbit embraces the primitive centre of rotating inertia; Saturn's mean position having been influenced by the locus of reciprocal rupture (Neptune's *m. p.**), the two chief points of incipient condensation (Jupiter's *s. a.* and Saturn's *s. a.*), and the mean positions of the other planets, as will be seen by the following table, in which Sun's mass = 10,000,000,000:

	μ_n	Authority.	$\rho_n \div \rho_3$	Authority.	$\mu\rho^2$
1. Mercury,	2,055	Encke,	.3871 *m.*	Leverrier,	308
2. Venus,	23,406	Hill,	.7233 *m.*	Leverrier,	12,246
3. Earth,	30,600	Newcomb,	1.0000 *m.*	Leverrier,	30,600
4. Mars,	3,233	Hall,	1.5237 *m.*	Leverrier,	7,506
5. Jupiter,	9,543,087	Bessel,	5.5193 *s. a.*	Stockwell,	290,693,300
6. Saturn,	2,855,837	Bessel,	10.3433 *s. a.*	Stockwell,	305,528,600
7. Uranus,	442,478	Newcomb,	19.1834 *m.*	Newcomb,	162,837,000
8. Neptune,	515,996	Newcomb,	29.7322 *m. p.*	Stockwell,	456,140,000

$$\left.\begin{aligned} \sqrt{\Sigma\mu\rho^2 \div \Sigma\mu} &= \rho_6 \\ \Sigma\mu &= 13{,}416{,}692 \\ \Sigma\mu\rho^2 &= 1{,}215{,}247{,}560 \\ \sqrt{\Sigma\mu\rho^2 \div \Sigma\mu} &= 9.517 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (6.)$$

Saturn's mean radius-vector is $9.539\rho_3$. The above result, therefore, indicates a slight preponderance, beyond the orbit of Neptune, of the unknown cosmical matter in our system. If the influence of all this unknown preponderance is equivalent to that of a mass about $\frac{3}{4}$ as great as Earth, at the locus of incipient subsidence ($2\omega = 6\pi^2\rho_3$), the mean moment of nebular rotation of each planet is represented by Saturn's mean position.

μ	$m(\rho_n \div \rho_3)$	$\mu\rho^2$
1	.3871	308
2	.7233	12,246
3	1.0000	30,600
4	1.5237	7,506
5	5.2028	258,317,647
6	9.5388	259,852,941
7	19.1834	162,837,000
8	30.0339	465,444,000
x	59.2170	76,446,000

* *a*, aphelion; *p*, perihelion; *m*, mean; *s*, secular.

$$\left.\begin{aligned} \Sigma\mu &= 13{,}440{,}100 \\ \Sigma\mu\rho^2 &= 1{,}222{,}948{,}248 \\ \sqrt{\Sigma\mu\rho^2} \div \Sigma\mu &= 9.539 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7.)$$

The ratio of Uranus to Neptune appears to have been determined by the incipient condensation of the system. For orbital velocity is proportioned to $\left(\frac{\mu}{\rho}\right)^{\frac{1}{2}}$; therefore, for any constant initiatory velocity, like v_{λ}, mass is proportioned to the radius of equal orbital velocity, or inversely to the $\frac{2}{3}$ power of the velocity of reciprocal orbital revolution, or to the cube root of the distance from the Sun. Designating the locus of incipient condensation (Neptune's secular aphelion) by ρ_{γ}, we find

$$\left.\begin{aligned} &\mu_7(\rho_{\gamma})^{\frac{1}{2}} = \mu_8(\rho_7)^{\frac{1}{2}} \\ &\mu_7(30.4696)^{\frac{1}{2}} = \mu_0\frac{(19.1834)^{\frac{1}{2}}}{19385} \\ &\frac{\mu_0}{\mu_7} = 22618. \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8.)$$

Newcomb's estimate of $\frac{\mu_0}{\mu_7}$ is 22600 ± 100.

The inner retrogradely-rotating planet (Uranus) is connected with the belt of directly-rotating planets by the two proportions :

$$\left.\begin{aligned} &\mu_7 : \mu_8 :: \rho_{3(3)} : \rho_{7(4)} \\ &\mu_7 : \frac{\mu_0}{1047.88} :: .9661 : 20.044 \\ &\frac{\mu_0}{\mu_7} = \frac{20.044 \times 1047.88}{.9661} = 22530 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (9.)$$

$$\left.\begin{aligned} &\mu_7 : \mu_3 :: v_{0(a)} : v_{0(3)} \\ &\frac{\mu_0}{22530} : \mu_3 :: \sqrt{214.54} : \sqrt{1.019256} \\ &\frac{\mu_0}{\mu_3} = \sqrt{\frac{214.54}{1.019256}} \times 22530 = 326{,}900 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (10.)$$

In equation (9), $\rho_{3(3)}$ = Earth's mean perihelion ; $\rho_{7(4)}$ = mean aphelion of Uranus. In equation (10), $v_{0(a)}$ = velocity of projection at the mean perihelion centre of gravity of Sun and Jupiter ($5.2028 \times 214.54 \times .95684 \div 1047.88 = 1.019256$); $v_{0(3)}$ = Earth's mean orbital velocity. The influence of Jupiter's mean perihelion position will be further shown in the following comparisons (13, 14).

In the early ellipsoidal or truncately paraboloidal nucleus indicated by Peirce's cometary and meteoric researches, of which Uranus (19.1836)

represents the perihelion, and Neptune (30.034) represents the aphelion, Jupiter's mean aphelion (5.4274) was central.

The centre of reciprocal rupture (Neptune's secular aphelion = 30.47), the paraboloidal centre (Jupiter's secular aphelion = 5.52), and the centre of the dense belt (Earth = 1), are connected by the geometrical proportion

$$1 : 5.52 : : 5.52 : 30.47 \ldots\ldots\ldots\ldots\ldots\ldots (11.)$$

The masses at the centres of rotary inertia (Saturn), and of early nebulosity (Jupiter), are proportioned to their respective gravitating tendencies towards the nucleal centre (Sun), or inversely proportioned to the squares of their vector-radii, so that their primitive moments of rotary inertia were equal.

$$\left.\begin{aligned} &\mu_5\rho_5^2 = \mu_6\rho_6^2 \\ &\frac{5.2028^2\mu_0}{1047.88} = \mu_6 \times 9.5388^2 \\ &\frac{\mu_0}{\mu_6} = 3522.3 \end{aligned}\right\} \ldots\ldots\ldots\ldots\ldots\ldots (12.)$$

Bessel's value is 3501.6, so that the theoretical mass is about .006 too small. This approximation, which was first pointed out by Professor Stephen Alexander, convinced me that all the cosmical masses must be determined by ascertainable laws, and thus led me to the results which are embodied in the present and previous communications.

The ratio between the masses at the centre of rotary inertia (Saturn), and at the centre of greatest condensation (Earth), appears to have been determined by Jupiter's perihelion influence and by centrifugal force, since the masses vary nearly inversely as their gravitating tendencies towards the Sun, or directly as the squares of their vector radii.

$$\left.\begin{aligned} &\frac{\mu_6\rho_6^2}{\rho_6} = \frac{\mu_3\rho_6^2}{\rho_0} \\ &\frac{\mu_0}{3522.3 \times 1.019256} = \mu_3 \times 9.5388^2 \\ &\frac{\mu_0}{\mu_3} = 326{,}661 \end{aligned}\right\} \ldots\ldots\ldots\ldots (13.)$$

The ratio between the masses at the nucleal centre (Sun), and at the centre of primitive nebulosity (Jupiter), combines the projectile, the centrifugal, and the square of the centripetal ratios, thus illustrating the thermodynamic law that equal quantities of heat correspond to equal increments of *vis viva* in simple gases.

$$\left.\begin{aligned} &\frac{\mu_0}{\mu_3} = \left(\frac{\rho_5}{\rho_6}\right)^2 \times \frac{\rho_5}{\rho_3} = \left(\frac{\rho_6}{\rho_5}\right)^4 \left(\frac{\rho_6}{\rho_3}\right)^2 \times \frac{\rho_6}{\rho_0} \\ &\frac{\mu_0}{\mu_3} = \frac{9.5388^6 \times 1.019256}{5.2028^4} \end{aligned}\right\} \ldots\ldots (14.)$$

The centrifugal ratios between Saturn and Earth (13), and the centripetal ratios between Saturn and Jupiter (12), are further illustrated by the

vector-radii of the centre of inertia and the centre of nebulosity. For, if we take a locus at $\frac{9}{11}$ of ρ_6, ρ_5 is at $\frac{2}{3}$ of the locus, or at the centre of subsidence-collision and the centre of linear oscillation, while the locus itself is at the centre of projection due to Saturn's spherical *vis viva* $\left(.4 \text{ of } \frac{5}{11} = \frac{2}{11}\right)$.

$$\frac{6}{11} \text{ of } 9.5388 = 5.20298 \ldots\ldots\ldots\ldots\ldots\ldots (15.)$$

This approximation gives a value for Jupiter's mean radius-vector which is only about $\frac{1}{200}$ of one per cent. too large.

In the dense belt, the moment of rotary inertia ($\mu\rho^2$) of Mars (7,506) is $\frac{1}{4}$ of Earth's (30,600), while that of Venus (12,246) is .4 of Earth's, thus indicating the influence of Sun's mean spherical moment of inertia, when expanded to Earth's orbit. The uncertainty with regard to Mercury's mass is too great to warrant any present speculation as to its origin, or its influence on the stability of the system.

The principal considerations, involved in these approximations, are:

1. Fourier's theorem, that every periodic vibratory motion can always be regarded as the sum of a certain number of pendulum vibrations.

2. The natural alternation of radial and tangential oscillations, in elastic media surrounding centres of inertia.

3. Maxwell's theorem of equality between *vires vivæ* of translation and *vires vivæ* of rotation.

4. Equality of action and reaction, especially in centripetal and centrifugal tendencies.

5. Perihelion indications of primitive centrifugal or rupturing force, and aphelion indications of primitive centripetal "subsidence."

6. Synchronism of rectilinear ($4r$) and circular ($2\pi r$) orbits.

7. The tendency of nodes in elastic media to establish harmonic nodes.

8. The laws of elasticity which connect arithmetical ratios of distance, with geometric and harmonic ratios of density.

9. The different variability, in condensing nebulæ, of times of rotation ($\propto r^2$) and times of revolution ($\propto r^{\frac{3}{2}}$).

10. Laplace's limitation of rotating elastic stress, by the radius of equal times of rotation and revolution.

11. The counteraction of the cyclical variations of stress, during each half-rotation, by the central force (g), after the analogy of projectiles from the Earth's surface.

12. The constancy, at the nucleal surface of any expanding or contracting nebula, of the stress-opposing value $\frac{gt}{2}$.

13. The tendency, in the primitive rupture of a nebula, to rotations in opposite directions.

14. The continual reciprocal action, between attracting centres, $\left(g \propto \frac{\mu}{d^2}\right)$ of disturbances proportional to mass.

15. The limiting influence of parabolic velocities, upon tendencies to dissociation and to aggregation.

16. The ratio of stress-opposing force, at Laplace's limit, to parabolic $\left(\frac{\pi}{\sqrt{2}}\right)$ and to orbital (π) velocity.

17. The influence of centres of linear and of spherical oscillation.

18. The conjoint influence of centres of nucleation, of density, of nebulosity, of rotary inertia, and of reciprocity.

19. The equations of relation between oscillatory and orbital motion.

20. The interesting and suggestive FACT, important in chemistry and general physics as well as in astronomy, that the central stress-opposing value in the solar system $\left(\frac{gt}{2}\right)$ is the velocity of light.

The Relations of the Crystalline Rocks of Eastern Pennsylvania to the Silurian Limestones and the Hudson River Age of the Hydromice Schists. By Charles E. Hall. With a Plate.

(*Read before the American Philosophical Society, January* 2, 1880.)

Recently Prof. Frazer called the attention of the Academy of Natural Sciences to the fact of the occurrence of the fossil *Buthotrephis flexuosa* in the Peach Bottom roofing slates of York county, Pennsylvania. As Prof. Lesquereux admits that this fossil does not extend below the Trenton limestone, it is in all probability within the Hudson river group. Dr. Emmons assigned this fossil to the Taconic System. Since Dr. Emmons' time, I think the fossiliferous bed of the Taconic system have been pretty well proven to be of the Cambrian series, which would place this Taconic fossil of Emmons somewhere about the Hudson river group.

I embrace this opportunity to state some facts from which I have drawn conclusions concerning the relative positions of the rocks forming the crystalline series of Eastern Pennsylvania.

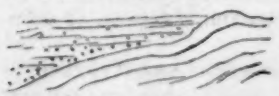
I shall endeavor to make my statements concise, and I think my reasoning will be understood.

We have the following series of rocks:

First. A series of granitoid, syenitic, quartzose, and micaceous schistose rocks, to be seen on the Delaware river above the city bridge at Trenton, and extending in a south-easterly belt across Bucks and Montgomery counties, as far west as Chestnut Hill, Philadelphia.

Second. A series of syenitic, hornblendic and quartzose rocks extending from the neighborhood of Chestnut Hill westward across the Schuylkill river, and covering a greater part of the northern portion of Delaware county. Fine exposures of this rock are to be seen on the Schuylkill river below Spring Mill, Montgomery county. This series may be the upper members of the first, or that extending from the Delaware river to Chestnut Hill.

Third. Potsdam sandstone, conglomerate, quartzite, and occasional schistose beds. In this group is included the Edge Hill rock which extends in an unbroken ridge from the Delaware river at Trenton to Huntingdon Valley in Montgomery county, and another ridge of the same rock from a point south of Willow Grove to Spring Mill, Montgomery county, near the Schuylkill river. The Edge Hill sandstone is identical with the quartzites flanking the north side of the limestone valley of Montgomery and Chester counties, and merges into them about Willow Grove. This, the Potsdam sandstone, rests unconformably upon the preceding two groups. The unconformity is seen at points east of Willow Grove, where the lower conglomerates contain fragments of the syenitic rocks.



Fourth. Dolomites, schistose or slaty micaceous beds, limestone, marble, hydromica schists and bastard marble. This group of limestones and schists rest upon the above group, and are the equivalent of the Cambrian limestones of the Great Valley. Trenton fossils have been found in the upper part of this group at Buckingham, Bucks county, by Mr. Ash. This Bucks county belt of limestone is cut off from the limestones of Chester Valley by the New Red Sandstone. There is no apparent unconformity throughout the limestone group. The lower beds are Dolomites; there are occasional alternations of shale throughout the mass. The marbles are all confined to the upper horizon and are followed by alternations of shale and shaly limestone.

Fifth. Hydromica schists, quartzose schists, chloritic schists, and occasional beds of quartzites and sandy beds and serpentines. It is difficult to draw a line between this group and the limestones, which pass into it by alternations exactly as the Trenton limestone passes into the shales of the Hudson river group in Central Pennsylvania. These are the Hudson river shales and flank the Chester Valley on the south from some point not far east of the Schuylkill river throughout the entire length of the valley. They extend south to the syenitic rocks of the second group, and west of the Schuylkill to the neighborhood of the Brandywine creek in Chester county, and gradually widening out to the south-west.

Sixth. Micaceous, garnetiferous schists, limestone in beds which rapidly thin out to the eastward, mica schists, and sandstones. The area of this group I have not determined, but it is principally confined to the southern central portion of Chester county, resting upon the Hydromica schists of the group above-mentioned. The eastern boundary is about the line of the Brandywine creek, although a tongue extends east of the creek to the neighborhood of Dillworthtown. This group rests unconformably upon the western extension of the *second* group.

Seventh. The mica schists of Philadelphia, mica schists, hornblendic, garnetiferous, talcose schists with soapstone and serpentine. These rocks lie to the south of the first and second groups of rocks, and are cut off on the west and south by the rocks of the second group from any connection with the rocks of Chester county. They rest unconformably upon the

first, second, third and fourth groups and are somewhat different in character from the fifth group, though they resemble portions of the sixth group.

There are besides these groups probably two serpentine horizons, which are undoubtedly unconformable deposits above the second group. I think the northern belt of serpentine may be considered as altered Hudson river rock; while the southern belts are doubtful.

The *first* and *second* groups are the oldest rocks, overlaid by the Potsdam sandstone unconformably. The Potsdam is flanked on the south by the *first* from Willow Grove to Chestnut Hill, where this group seems to be succeeded by the *second*. It may be only the upper part of the first, however, the sandstone rests on both. The *first* group is flanked on the south by the Edge Hill rock or Potsdam S. S. from the Delaware river to the Pennepack creek in Montgomery county. To the north the upturned edges of these rocks are overlaid by the New Red Sandstone. West of the Pennepack creek the structure is plainly a synclinal, the axis of which would be just south of Willow Grove; and an anticlinal, the axis being about on a line from Abington to Attleboro.

The syenitic rocks flank the Potsdam on the north of the synclinal north of Willow Grove, encircle the end of the synclinal and are exposed along the anticlinal to a point near Chestnut Hill. The Potsdam sandstone is not found between Huntingdon Valley on the Pennepack and Waverly Heights, south-west of Edge Hill P. O., along the south side of the anticlinal.

The overlying limestone occurs just south of Huntingdon Valley, overlying the sandstone, and extends westward beyond the Pennepack creek some distance, lying *immediately above* the gneisses of the first group.

The unconformity is evident between the gneisses of the first group and the limestones, and inasmuch as the limestone occurs almost on the line of strike of the sandstone which again appears at Waverly Heights, it would seem to be sufficient proof of its unconformity to the sandstone.

Resting on the Potsdam sandstone from the neighborhood of the Delaware river to a point near Huntingdon Valley, and on the limestones between Huntingdon Valley and Waverly Heights, and also on the Gneisses of the first group, we have the micaceous, garnetiferous schists of the Philadelphia group. These are unconformable, resting upon and against these lower rocks.

The sandstone along the south margin of the synclinal, which I spoke of as extending from Willow Grove to the Schuylkill is, most of it, very different in character to that along the north side. The difference in character on the north and south sides of the valley may be due to the infiltration of ferruginous matter derived from the New Red sandstones which flank the group and overlap it on the north.

The dips are high, the rocks are sandy, light colored and very free from iron as a rule; the ridge is known as Edge Hill. Towards the Schuylkill it dies down rapidly, and disappears below the limestones at Spring Mill, not only swallowed up by a fault, but unconformably overlapped as well.

On the north side of this synclinal valley, we find the quartzites and

sandstones forming prominent ridges, having a much less dip and covering greater areas. There are several cynclinals and anticlinals, the axes of which form an obtuse angle to the line of strike of Edge Hill. These folds die down very rapidly to the eastward, but are marked by slight irregularities in the line of strike of Edge Hill.

I have been long inclined to consider the elevations of sandstone along the north flank of the limestone valley, as having been caused by folds and faults, but I do not see any proofs of faulting. But there is evidence of unconformity between the two groups, as at Spring Mill, where the limestone overrides the upturned Potsdam; at a point west of the second crossing of Sandy Run by the North Penn. R. R., just south of Fort Washington, the limestone occurs in a bay in the sandstone, having a slighter dip. Just south of Mogeetown, east of the Schuylkill river, near Norristown, the limestones rest unconformably upon the Potsdam, to all appearances.

The anticlinal ridges of Potsdam extending diagonally into the valley, are flanked on both sides by limestone, and, in some cases, disappear below the limestone which encircles it; but in the most eastern fold I doubt whether the limestone is connected.

The marble is confined to the south side of the valley. The dip of the limestone being to the south, it would place them at or near the top. Marble quarries are found in Chester county, close along the southern margin of the limestone valley, and in close proximity to the slates. In Montgomery county the same rule holds good, and very shortly after the disappearance of the slates to the east of the Schuylkill, we find the marble is missing as well.

The rocks rise rapidly to the eastward. The slates of the South Valley Hill are in regular succession upon the limestone. This may be seen where the South Valley Hill ends at Gulf Mills. The structure is clearly proven by the succession of rocks, which is marble, bastard marble, shale, on the north side of the synclinal and a double repetition on the anticlinal at Gulf Mills. The cove made by the erosion of the anticlinal is just west of Gulf Mills, west of Conshohocken. The transition shaly limestones are repeated several times by minor contortions, and extend over a wide area from Gulf Mills to the Schuylkill river.

The alternations from the limestone into the slates is everywhere visible along the southern margin of the Chester valley.

The slates are traversed by a trap dyke, which crosses the Schuylkill at Conshohocken. I do not think it marks the line of any disturbance of importance. The synclinal and anticlinal of the slates do not cross the Schuylkill river. The slates flanking the marbles east of the Schuylkill lie in a monoclinal, pitching to the south against the Potsdam, which was

upturned along the line from Spring Mill to Edge Hill P. O., probably prior to their deposition. This is evident from the fact that the limestones lap over the rocks of the second group at West Conshohocken.

It may be that the great unconformity of the measures west of the Schuylkill river cannot be explained without a fault along the line of junction.

The southern margin of the slates of the South Valley Hill is somewhat irregular, they come in contact with the rocks of the *second* group as far west as the east branch of the Brandywine creek, or that neighborhood, where they are succeeded and overlaid by micaceous garnetiferous rocks with limestone of the *sixth group*.

The southern boundary of the South Valley Hill slates or Lower Hudson river slates, is about on a line from West Conshohocken to a point about four miles north-west of West Chester, and gradually diverges from the line of the Chester valley as we proceed westward. This divergence is caused partially by the flattening of the measures, and partially by their increased thickness.

The sixth group which flanks the South Valley Hill rocks on the south and overlies them, increase rapidly in thickness to the west of the Brandywine creek. This group lies upon the rocks of the *second* group and encircles the western end of that area. The East Branch of the Brandywine creek cuts along close to the line of junction, between these groups. The schists in places are found on both sides of the creek, while at other points the syenitic rocks of the *second* group extend west of the line. The limestones of this group are well exposed in the neighborhood of Doe Run. The most easterly exposures are at Caleb Cope's and Copesville on the Brandywine; also at Brinton's Bridge on the Brandywine, and two localities east of Brandywine creek, one in Birmingham and the other in Thornbury township.

The locality at Caleb Cope's place, north-west of West Chester, is a similar deposit to the one at Brinton's Bridge, a thin bed of impure crystalline limestone between beds of schistose rock.

The first locality is on a line with the locality at Cope's Mill, and as can be seen by the map, is also on a line with a number of limestone quarries west of it. I have satisfied myself by walking over the ground that they all belong to one horizon, and if not absolutely continuous they are only broken by the thinning out of the limestone itself. The locality at Brinton's Bridge is on a line with the quarries of East Marlborough and London Grove townships, and although it is a small bed, it is flanked on both sides by the same rocks which flank the heavier beds further west. The fact of it being a thin bed bears me out in the assertion that all these beds thin rapidly towards the east.

I am not prepared to say whether or not there is more than one horizon of limestone in this portion of Chester county. I am forced to the conclusion as to its superposition to the South Valley Hill slates, as the succession is clearly seen along the East Branch of the Brandywine Creek.

The rocks of this group seem to vary considerably, and it is not improbable that they may have to be subdivided, as I have included all the

schistose rocks with limestone from the South Valley Hill slates along the East Branch of the Brandywine to Chadd's Ford or the Maryland line, and west at least as far as Avondale, Chester county. From their position above the slates of the South Valley Hill, which are Hudson river, they belong to a limestone group above the Hudson river group. Inasmuch as no fossils have been found as yet, it is difficult to assign them to any particular age, but I am inclined to think that they may be Silurian and possibly Helderberg.

There may be an unconformity between these schists and sandstones and the slates below, but as yet I have not been able to determine the area of the upper group accurately, and before this is done it is impossible to state decidedly what the relation is.

In Eastern New York, south-west of Albany, we find the Hudson river shales and sandstones overlaid by the Niagara in thin beds of concretionary limestone, often not recognizable, followed by the Helderberg limestone, the Oneida conglomerate, Medina sandstone, the Clinton group, and Onondaga shales, all having died out east and north before reaching the Helderberg escarpment. May we not have similar structure here?

The limestones of the Chester Valley extend in an almost straight line from the Schuylkill river to the neighborhood of Quarryville, in Lancaster county, where the straight valley ends and connects with the great limestone valley of Lancaster county at Camargo P. O.

At Camargo P. O., according to Prof. Frazer's map, a tongue of slates connects across the limestone and is colored the same as an area of rock north of the limestone valley, extending to the county line south and east of the Gap P. O.

The limestone valley from the Schuylkill to Quarryville or thereabouts is a monoclinal, the beds all pitching to the southward, followed by Chloritic schists, Hydromica schists and Mica schists, which overlie the limestones. This is clearly demonstrated at the eastern end of the South Valley Hill, which is formed by these slates. The marbles, which are always confined to the southern edge of the valley, mark the horizon of the Trenton limestone with its alternations of slate and slaty limestone, passing by alternations into shale and slate of the South Valley Hill or Hudson river group. Just north of Gulf Mill a synclinal of the slates dies out, and at Gulf Mill we have a double repetition of the alternations of impure limestone and slate found flanking the synclinal on the north, which proves Gulf Mill to be on an anticlinal axis. (See wood cut.)

The dips, as a rule, are pretty high towards the Schuylkill river, varying from 50° to 85°. But as we proceed westward they become somewhat less, which may in part account for the widening of the slate area before spoken of, but there is a marked thickening in the beds to the southwestward, which also must be taken into consideration.

Owing to the short time I have for the preparation of this paper, I will proceed to carry these determinations of horizons south-westward.

At Camargo P. O., we would have an anticlinal of slates overlying the limestones, which anticlinal would be on a line of the axis of the Tocquan creek anticlinal recognized by Prof. Frazer on the Susquehanna.

The lower portion of Pequea creek flows along an anticlinal in which the limestone is exposed along the creek to the neighborhood of Marticville P. O. A tongue of slates extends eastward between the Pequea and Conestoga creeks as far as Willow Street P. O., which is on a line of a synclinal axis shown to end at Compassville, and along which the Pequea creek flows from Compassville to Wheatland Mills P. O. An anticlinal having its axis about on a line between Petersville P. O. and the mouth of Conestoga creek. A synclinal of Chloritic slates ending somewhere near Indian town. An anticlinal exposing the limestone, extending from Prospect Furnace P. O., in York county, to Lancaster.

A synclinal of slates extending from a point south-east of Montville P. O. to Washington Manor P. O., and crossing the river, is evident from the distribution of slates in York county, beyond the line of the Peach Bottom R. R. Lastly, we have a monoclinal flanking the Chickis Potsdam, extending from Hempfield, which is at the extreme eastern end of the Potsdam anticlinal through Columbia in Lancaster county, and Wrightsville, York, Springforge to Hanover in York county. North of York the limestone is not continuous across to the northern arm of the anticlinal, which is principally covered by the Trias, but has a considerable exposure in Lancaster county. The slates, therefore, south-east of the limestones of Chester county, are of Hudson river age.

The slates of York and Lancaster counties, which includes the roofing slates of Peach Bottom, are a continuation of those of Chester county, which flank the limestone on the south, and are referable to the same group.

The serpentines of Radnor township, Delaware county, and those of Easttown, Willistown, East and West Goshen, are undoubtedly altered beds of the South Valley Hill slates, or Hudson river slates. They lie unconformably upon the syenitic rocks of the second group.

The probability is that all the serpentines of Chester county will be found to belong to the Hudson river group, and are possibly pretty nearly on the same horizon as the limestones of West Bradford, Merlin, east and west Marlborough, London Grove, Kennet, and other townships of southern Chester county, although I have spoken of this limestone group as being possibly of Helderberg age. The serpentines of southern Lancaster county are undoubtedly altered beds of the Hudson river group, and from their relative position to the roofing slates of Peach Bottom, would be in their proper place.

Dr. T. Sterry Hunt insists that the serpentines of the Schuylkill are below the Philadelphia schists. If they are, the structure would be even more simple than otherwise. Placing them below the Philadelphia schists they would be on a horizon with the serpentine beds of Chester county, and these Philadelphia rocks equivalent to those which they resemble in southern Chester county: but if the serpentines of Montgomery and Delaware counties are above the Philadelphia series, they necessarily belong to a later age than those of the Hudson river group.

At present I am inclined to place these serpentines above the Philadel-

phia rocks, and, by so doing, assign the Philadelphia series to a higher group than the Hudson river.

The relation of the Philadelphia schists to the schists of the *sixth* group is not fully determined, but they bear a great resemblance to them, and in many respects are identical. The syenitic rocks of Delaware county which belong to the *second* group, cut off the connection between them.

To all appearances the serpentine belts, which are visible on the Schuylkill river at Lafayette station, Montgomery county, and at a point just north of them, are above the mica schists of Philadelphia. The southern belt extends in an almost unbroken line from Chestnut Hill, Philadelphia, to Bryn Mawr, in Montgomery county. A less prominent belt extends from the Schuylkill river to the neighborhood of Rosemont station, on the Pennsylvania R. R., in a parallel line to the first belt.

The serpentines of Delaware county are on a general line of strike with these belts, and without doubt represent the same horizons.

There is no evidence in this section of the Oneida conglomerate or Medina sandstone, as far as I can observe, but there are sandstones in the south-eastern portion of Chester county I have classified with the sixth group, which may prove to belong to a sandstone formation succeeding the Hudson river slates.

LIMESTONE.

MICA SCHISTS.

III. { SERPENTINES.
GARNETIFEROUS SCHISTS.
HYDROMICA SLATES.
CHLORITIC SLATES.
ALTERNATIONS OF SLATE AND LIMESTONE. }

II. { MARBLE.
SLATE.
DOLOMITES. }

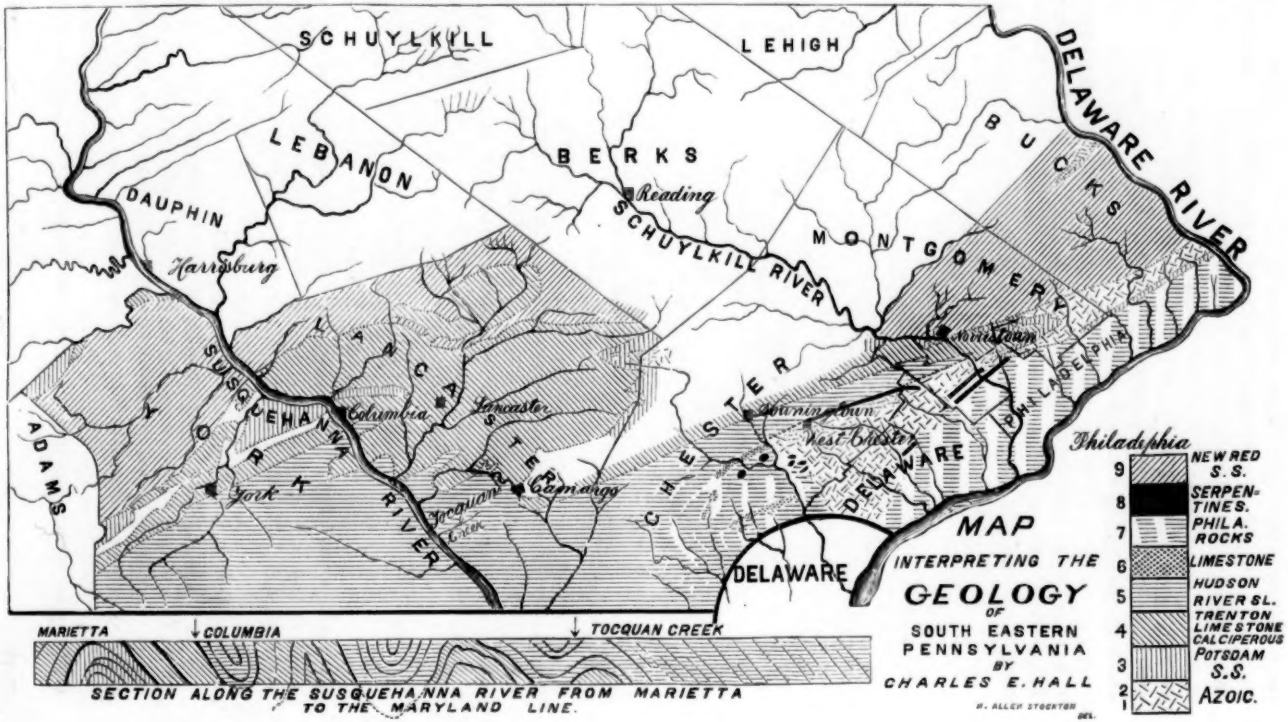
I. POTSDAM SANDSTONE. QUARTZITE.

SYENITIC AND GRANITIC ROCKS.

There is no doubt that magnesian beds may be altered into serpentines wherever they may be, and the mere fact of serpentine existing at any place is not proof of a given horizon, but it is in all probability confined to definite horizons within limited areas.

The whole question of structure would be easily solved could we prove what is everywhere indicated, viz, a gradual subsidence of the formations north-west of the line of junction between the South Valley Hill slates and the syenitic rock of the *second* group, which change in level, at the close of the Hudson river group, allowed the upper magnesian beds of that group to be deposited over the edges of and encircle the *second* group.

The evident nonconformity between the Philadelphia schists and the


SCHUYLKILL
LEHIGH
DELAWARE RIVER
LEBANON
BERKS
BUCKS
DAUPHIN
Reading
Harrisburg
SCHUYLKILL RIVER
MONTGOMERY
Norristown
PHILADELPHIA
LANCASTER
YORK
SUSQUEHANNA RIVER
Columbia
Lancaster
Conestoga
Tocquan Creek
ADAMS
CHESTER
Downingtown
West Chester
DELAWARE
DELAWARE
MARIETTA
COLUMBIA
TOCQUAN CREEK
SECTION ALONG THE SUSQUEHANNA RIVER FROM MARIETTA TO THE MARYLAND LINE.
MAP
INTERPRETING THE
GEOLOGY
OF
SOUTH EASTERN
PENNSYLVANIA
BY
CHARLES E. HALL
H. ALLEN STOCKTON DEL.
Philadelphia
9 NEW RED S.S.
8 SERPENTINES.
7 PHILA. ROCKS
6 LIMESTONE
5 HUDSON RIVER SL.
4 TRENTON LIMESTONE CALCIPEROUS
3 POTSDAM S.S.
2 1 AZOIC.

rocks of the *first, second, third* and *fourth* groups may be due to subsequent faulting, but they are nevertheless more recent.

The accompanying map gives the general outline of the groups. I have used Prof. Frazer's section along the Susquehanna river for illustration with my interpretation. He produced the section through *Chickis* in his report C. C. of the Second Geological Survey. The changes I have made are on structural grounds.

An Account of an Old Work on Cosmography. By Henry Phillips, Jr., A.M.

(*Read before the American Philosophical Society, January* 16, 1880.)

It has occurred to me that as all knowledge is within the scope of our pursuits, an analysis of a work on Cosmography, the production of a once famous author, might not prove unacceptable. The errors among which men once blindly groped, the silly tales of wonderment with which returned travelers were wont to astonish their stay-at-home friends, the absurd statements once received as absolute facts, but later exploded by the Ithuriel-touch of truth, now at these later days, when we are entirely freed from superstition, folly and ignorance, and a blind reliance upon the *ipse dixit* of anyone, may afford us a lesson pregnant with instruction. It is, therefore, with this view that I venture, this evening, to present to our Society an account of a book which bears for its title :

"Cosmographia Universalis Libri VI. in quibus juxta certioris fidei scriptorum traditionum describuntur omnium habitabilis orbis partium situs propriæque dotes, regionum topographicæ effigies. Terræ ingenia quibus fit ut tam differentes et varias specie res et animatas et inanimatas ferat. Animalium peregrinorum naturæ et picturæ. Nobiliorum civitatum icones et descriptiones, Regnorum initia, incrementa et translationes. Regum et principium Genealogiæ. Item omnium gentium mores, leges, religio, mutationes; atque memorabilium in hunc usque ad annum 1559 gestarum rerum Historia. Autore SEBAST. MUNSTERO."

On the recto of the title-page appears the portrait of the author, an elderly, hard-featured man, beneath which are two Latin poems, laudatory of that distinguished person and his work. The preface is dated at Basle, March, 1550.

Sebastian Munster may serve us as an example of the scholars of the olden time. He was born at Ingelheim, in 1489, and became a Cordelier monk, but, having adopted the opinions of Luther, he renounced the robes and the yoke of a cloister and took to himself a wife. Such was the usual course in those days which the converted clergy took to show their hatred to the tenets of the church of Rome, where enforced celibacy was of primary importance, and weighed so heavily upon them.

For several years Munster taught at Basle, where he gave to the public many valuable works, having rendered himself so very learned in geographi-

cal and mathematical science, and in the Hebrew language, that he was known as the Esdras and the Strabo of Germany. The mere enumeration of his writings in Gesner's *Bibliotheca* occupies several folio pages. He died at Basle, of a prevailing pestilence, on the twenty-third day of May, 1552, in the sixty-third year of his age.

This book was one that became very popular and ran through many editions. It was published at Basle originally in 1550, then successively in 1569, 1574, 1578, 1592, 1598 and 1614. All these editions were in German. The Cosmography was issued in Latin in 1550 and 1554, having been translated by Munster himself. It was issued in French at Basle in 1552, and at Paris in 1575; in Italian at Bale, 1558. A selection from its contents, entitled "A treatise on the New India with other newe founde lande and islandes as well eastwarde as westwarde by Sebastian Munster, translated into English by Richard Eden," was published at London in 1553, and another translation, "A brief collection of strange and memorable things gathered out the Cosmography of Sebastian Munster," was published at London in 1574.*

The book, which is crowded with quaint and rude wood-cuts, begins with a number of full-page maps, among which are the world on the Ptolemœan system (America, of course, not shown), surrounded by a border representing the various winds, Europe and its various divisions (embracing the kingdoms of Bohemia, Hungary, Poland), Africa, Asia and the New World. The British Islands were not of sufficient importance to warrant a special map and are crowded up towards the top of a general map of Europe in such a manner that very little of Scotland is shown. England was at this time under the dominion of Edward VI. (1547–1553), and the influence exercised by it upon the politics of Continental Europe was very inconsiderable; it was looked on, in fact, only as a semi-barbarian island in the far-off northern seas.

Naturally the author begins with the beginning and starts with the creation of the world, drawn from Biblical sources. To this chapter is prefixed a wood-cut representing the world as a plain from whose bounds arise lofty mountains, inhabited solely by animals. In the background is a circle of flames; in the foreground is an ocean with fishes and an old-fashioned high-pooped Dutch galliot, navigating apparently by its own instinct (for not a living being is anywhere to be seen upon it) the new-made waters. Sea monsters raise their heads from the billows and gaze with rapt amazement at the ship, taking it, doubtless, for some novel marine creation. Overhead are shining the sun, moon and stars, while God, represented as an old man with a papal tiara upon his head, is seated between the heavenly bodies upon a cloud. At each of the upper corners of the plate is an angel; at each of the lower corners a very satyr-looking demon.

Then follow chapters upon land, sea, islands, the earth with its vegetable and mineral wealth, earthquakes, hot springs and baths, fires existing

* Brunet.

in the bosom of the ground, natural phenomena, metals and their mode of being mined, the mines and the spirits and devils who rule in them, and the localities where metals are found.

On page 9 is represented a man using the divining rod (*Glueck-ruth*) of forked witch hazel, that is turning in his hands as he steps over a place where mining operations are being conducted. A section of a hill is shown with men at work breaking ore and loading a rail car upon a tramway which leads to an elevator running up to a level with the opening of the mine.

On page 11 we find a machine in use for crushing the crude ore, represented as somewhat similar to a modern quartz crusher, the motive power of which is furnished by an overshot-wheel.

In speaking of the earth and its dimensions, the author says it is hollow in the centre; that this opening or void space is full of flames, and is hell; that it is of sufficient capacity to contain all the millions of damned souls that it will be required to hold. That the earth itself is round, about 5400 (German) miles in circumference, and about 1718 (German) miles in diameter.

There are accounts given of early sea navigation, the deluge, and the terrestrial paradise, of which latter there is an illustration exhibiting the Garden of Eden with a fountain in the centre, walled around with crenated battlements, a lofty tower rising from the middle of the enclosure, and we are also favored with a view of the trees of life and knowledge.

On page 37 we find a picture representing the migration of some early tribe, every one of whom, male and female, is dressed in the fashions prevalent among the Germans of the sixteenth century; before them is drawn a low truck containing standard stores for the journey, in which are several barrels distinctly suggesting to the mind of the observer the idea of *beer*. The parade is passing an old castle.

On page 42 occurs a description of the British Islands, accompanied by a map of the same. England has only three towns represented, viz: London, Dover, and what the engraver is pleased to call *Ochsenfürt* (Oxford). Scotland has only Edinburgh, and Ireland a large city in the extreme south, called *Vatford*. The shape of the British Islands is simply atrocious. It must be a mortification to an Englishman to consider of how little importance his country was but three hundred years ago, while kingdoms that now have sunk into oblivion and their names even lost, were then potent, flourishing, and even objects of dread.

The description of England is short, and contains nothing of interest. Speaking of Ireland, reference is made to the rebellion of 1534, and the great slaughter that followed in its wake. The manners of the Scotch are condemned, but their mental and moral qualities much praised; a statement is made that the use of coal for burning is so common, that in Scotland the beggars supplicate it for alms. In this kingdom is found the very wonderful stone known as *Gagates* (p. 45):

"A stone which, although of a rough and common appearance, yet partakes

somewhat of a Divine essence, for it kindles fire in running streams which nothing but oil can extinguish. If any one should drink the water in which this stone has been steeped, if there has been any stain upon the chastity of such a one, he (or she) will immediately be compelled to micturate, nor can he (or she) possibly avoid it: but if it is drunk by one who is pure, no such evil effects will result."*

The English language is thus spoken of: "It is a mixture of many tongues, especially German and Gallic. Formerly, as we learn from Bede, it was entirely Germanic, who thus writes: 'The ancient inhabitants of England were accustomed to reckon their months according to the course of the moon, calling the moon *Mona* (which the Germans call Mon), and a month, *Montha*. December was called *Haleg monath* (*i. e.*, Holy month), and April, *Eoster monath*, from a goddess named *Eostre*, to whom the Teutonic tribes were wont to sacrifice in this month in Pagan times. May was called *Thri melci* (thrice milked), because in that month they usually milked their cattle so often.' This passage," continues Munster, "is not to be in the printed copies of Bede's works, but I found it in a manuscript which Glareanus ex Nigra Silva in 1545 sent here to Basle."

Scotland possesses yet another wonder (p. 49):

"Here there are trees which produce a fruit enveloped in leaves; this when the proper time arrives falls down into the water below and is turned into a living bird which is called the *Tree Goose*. This tree grows in the island of Pomonia which lies to the north of Scotland at a short distance therefrom. This tree is mentioned by all the old Cosmographers, especially Saxo Grammaticus, so you must not think we have made up this account. Æneas Sylvius writes in this manner concerning it: 'We have formerly heard that there was a tree in Scotland growing on a river's bank, whose fruit was in the form of aniseed, which when it had come to maturity fell of its own accord, some on the land and some into the water; and those which fell on the land petrified, but those that alighted in the water soon receiving life began to swim and afterwards on their wings and pinions took to flight. When we were in Scotland in the reign of King James hearing of these things we endeavored to investigate them, all persons uniting in affirming the marvel, but the further to the north we traveled the further was removed the place of the miracle so that it was finally said not to exist in Scotland at all but in the Orcades Islands.'"

The description is accompanied by a wood-cut representing the tree with its fruit in various stages of development. Some are entirely closed, some are a crack open, some have the heads of the birds peeping out of them. At the base of the tree is water within whose vivifying influences a number of these rare exotics may be seen disporting themselves. Owing to the favorable position of the tree, only two of its fruits are threatened with premature extinction by falling upon the dry land.

There is a map and metrical description of the city of Paris, dated 1548, and on page 185 is a large two page plate representing the theatre at Verona, in its perfect state as it formerly appeared, but of which "only ruins now remain." It is a huge edifice built upon arcades and around it

*The Venerable Bede speaks of a stone called *gagates*, and says: "it (Britain) hath much and excellent jet, which is black and sparkling, glittering in the fire, and, when heated, driveth away serpents."

a river is flowing. It was ascribed to Octavius and is said to have furnished seats for 23,184 persons.

At page 249 is a description of the dialect formerly spoken in the island of Sardinia.

At page 408 is given a description of two terrible earthquakes which occurred at Basle in 1346 and 1356, accompanied by a wood-cut representing the overthrow of the city; the church steeples, palaces and houses being raised in the air and cast upon the ground.

At page 431 mention is made of curiosities found in the mines of Alsatia, as follows:

"There is in this region a lake extremely long and broad and deep, which contains many kinds of living animals and reptiles reproduced by nature in pure copper on the neighboring rocks so that they can be most easily recognized and known. That most learned man John Hobensack sent me a specimen of one of these stones which figure I have reproduced here."

According to the picture it is a very ugly looking fish, with a large head and fins close behind the junction of the head and body, and a single fin lower down; the body seems coated with plates like a crocodile, with a dividing line running up the back.

At page 488 occurs a description of the town of Mayence, in which is found a description of the invention of the art of printing, which is attributed to John Guttenberg.

At page 489 is a long description of the invention of cannon and gunpowder, which latter is ascribed to Bernhard Schwarz. A picture of the very rude artillery in use in those days accompanies the letter-press.

At page 493 occurs an account of the tradition of Bishop Hatto and the Mouse-tower, where it is stated that a similar tale is told of a king and queen of Poland (names not given) who, with their children, were devoured by mice. A woodcut shows the tower on an island in the Rhine, with the mice swarming up the walls, climbing into the windows, and gnawing at the foundations.*

A monster born in the Palatinate is thus described on page 625:

"In the year 1495, in the month of September, a woman at Bierstadt gave birth to a monster in the form of two girls, whose bodies were joined together at the forehead, so that they always looked into each other's eyes, but in all other respects were entirely distinct and separate. I (Munster) saw them myself at Mayence, in the year 1501, when they were about six years old. They were forced to have a common will, to walk together, to sleep and rise together; and when one went forward the other went backward. Their noses a'most touched each other, and their eyes, instead of being straight to the front, were crooked to one side. They lived to be almost ten years old, at which time one of them dying, it was necessary from the decay of the corpse to cut them apart; but the wound mortified, and the survivor quickly followed her sister to the grave. The explanation given for this prodigy was that as a pregnant woman was conversing with another, a third suddenly coming up from behind knocked their heads together, and the impression of the fright was communicated from the mother to the fœtus."

* Vide also Camerarius, Vol. II, p. 45.

There is a wood cut representing these girls as joined at the forehead, and looking into each other's eyes.

A representation of the manner of coining money in vogue at that time, is found at page 692, and at page 703, men and women are represented bathing together, entirely nude, in one of the mineral bath resorts. The Vehm Gericht is described on page 748, the animals of Prussia at 784, and the martyrdom of John and Hieronymus Huss at page 801.

At page 820 is an engraving which recurs very frequently throughout the book. The subject is, "A great contention between two kings." Two men in regal paraphernalia are represented as hauling and mauling and pulling and tugging at each other, in a tremendous state of excitement, clutching at each other's beards and hair and garments. This probably conveyed to the readers, better than the mere force of words, the close and violent nature of a combat between sovereigns.

On page 832 is a description of Norway, and of the monsters that abound therein. Among these the whale stands pre-eminent with a head shaped somewhat like that of a dog, with huge projecting tusks like those of a boar, and is shown in the act of swallowing a man, who is all out of sight except his head and arms. His comrade, more fortunate, appears on the mainland, naked and in full flight. A vessel is being sucked down into a whirlpool, of which the text states that there are many on the Norwegian coast. The ocean is seen swarming with fishes, and a man is portrayed following the sport of angling with a bait that resembles a bundle of hay.

The Lord's Prayer in the language of the Lapps and Finns is given at page 847, and on the same page a description of Iceland occurs, with a representation of Mount Hecla in full eruption.

A short description is given of *Greenland*, at page 850, as follows:

"Grünland means Green Land (*viridens terra*), so called on account of the luxuriant herbage found there. Of which, as well as of cattle, there is exceeding abundance, as may be seen from the reports brought back by those who have voyaged thither that they make great amounts of butter and cheese, from which we may conjecture that that country is not rough with mountains. It contains two Bishoprics, whose Bishops are ordained by the Archbishop of Nidross. The people, through the negligence of their spiritual pastors, have almost relapsed into heathenism, being of fickle disposition, and greatly given to magic arts. By means of incantations and spells, they are reputed to be able to raise, at will, tempestuous storms, and to cause the shipwreck of foreign vessels whose remains they desire to plunder. Their own vessels being of *skins*, and very light, are quite safe from collisions against their rocks."

An odd two-page illustration occurs at page 852 of the monsters which are to be found in the Northern Regions. So laughably absurd, so ridiculous and so diverse in their representations that no pen could ever attempt to describe them with the slightest approach to justice. On examining them one feels tempted to exclaim with Bottom, when he awoke from his asinine hallucination, "The eye of man hath not heard, the ear of man hath not seen, man's hand is not able to taste, his tongue to conceive, nor his heart to report" what these remarkable figures were intended to convey.

Monsters of every conceivable age, shape, size, appearance and color; fish with the heads of owls; whales with crocodile's scaly backs and the heads and tusks of wild boars; pig-headed animals with fish's tails and elephants' bodies; fish with cats' faces and ruffles around their bodies; fish that look like turnips and carrots; fish swallowing young pigs; fish with leopards' heads and claws; fish with wolves' heads; fish with oxen's heads; griffin-headed fish; fish with heads of birds and bodies like dock leaves; fish attacking men; gigantic lobsters and crawfish; wonderful fish that look like crows; a sea serpent swallowing a vessel; and many other objects which the credulity and superstition of our ancestors accepted in good faith. A whale is represented as attacking a vessel whose mariners are vainly endeavoring in accordance with the established custom to divert its attention from their ship by throwing overboard a number of small barrels or tubs; a usage from whence arose the saying of *casting a tub to the whale*, meaning to divert one by means of a lesser matter from a greater one. In one corner of the plate occurs the barnacle tree, already described, with its fruit.

At page 905 is the portrait of a monster who was born at Cracow in February, 1547, and lived three hours. It is a boy whose feet and hands terminate in four duck-like webs instead of fingers and toes. There grows out of each knee and out of each elbow a dog's head, being four in all, while from each of his breasts protrudes the head of a ram. At the bottom of the breast bone in his belly is an extra pair of eyes; a forked tail waves up to his head. He has a long and flexible elephant's proboscis in place of an ordinary nose; large and round, saucer-shaped eyes, and an extra pair of ears growing out of the corners of his eyes, which, as well as the ears in their usual position, are formed like those of a rabbit.

At page 1025 occurs the history of the Tower of Babel, apropos of which Munster gives the word bread in fourteen languages, and speaks of Noah as being identical with *Janus*.

The Phœnix is described on page 1034, and at page 1045 the Hyrcanian Tiger; the latter as follows:

"It is a large animal of various colors, which is quite tame when its hunger is appeased. It sleeps three days at a time and upon awakening it washes itself and raises a cry and emits a peculiar scent that attracts to it all sorts of wild animals, for with all such does it preserve friendly relations save with the dragon and with the asp."

The Tartars are described at page 1060 as being anthropophagi, and one of them is delineated as superintending the process of roasting a human body impaled upon a spit over a fire, in the act of turning the viand carefully so as to cook it evenly on all sides.

At page 1066 is a description of India and its customs, one of which is represented by a woodcut of an elephant attached to a plough and serving as a tiller of the soil.

Dragons are seen on page 1069 with all their usual fabulous horrors of scales and wings and jaws; duels between these animals are pictured as of

frequent occurrence. Nor is the griffin forgotten among the prodigies which nature is supposed to have lavished upon the lands of the Orient.

At page 1073 a hippopotamus is figured as a horned horse with huge fangs, whose body is half concealed in the river. Snakes are also represented with several heads, each of which bears a regal crown. Still further on (at page 1080) we find the Cynocephali, "the men whose heads do grow beneath their shoulders," the people who have but one eye and that in the centre of their forehead, a race of double-headed dwarfs and a nation whose feet are more than twice the size of the rest of their bodies. These last are represented as taking their ease on their backs under the shadow of their own feet, which they are holding propped in the air supported by their hands. The pygmies and their incessant warfare with their hereditary enemies the cranes, are not forgotten.

At page 1410 occurs a woodcut illustrative of the customs of Cathay which *modestiæ gratia* is transcribed in the German of the edition of 1563:

"Wañ einer sein tochter nie kan aussteürn, nimpt er trum̃en und pfeyffen, und zeucht mit seine töchtern uff den marckt, und so jederman herzu laufft als zu einem offentlichen spectakel oder schawspil, hebt die tochter ire kleider dahinden auff biss an die schultern, und lasse sich dahinden besehen, darnach hebt sie sich dafornen auch auff biss über die brust, und lasst ihre leib daforne auch sehen, und so etwann einer do ist dem sie gefalt, der nimpt sie zu der eh, und thut kein blinden kauff."

The foregoing extracts will give a general idea of the work and its contents. To transcribe at greater length would be profitless, as the remaining matter for the most part presents no novelty either of subject or treatment. There are narrations of the voyages of Columbus and Vespucius, but differing in no wise from the generally received accounts.

There is a very remarkable map of the New World, which, however, I pass over for the present, intending in the hereafter to make it a study by itself.

It is needless to dilate upon the pleasure to be derived from the perusal of old books. Cardan says with much truth:

"That as in traveling the rest go forward and look before them, an antiquarian looks around about him, seeing all things, both the past, present and future, and so he alone hath a complete horizon." "Such studies allure the mind by their agreeable attraction on account of the incredible variety and pleasantness of their subjects and excite to further steps toward knowledge. What greater pleasure can there be than to peruse those books of cities put out by Braunus and Hogenbergius? To read those exquisite descriptions of Magnius, *Munster*, Herrera, Laet, Merula, Boterus, Leander, &c.? These famous expeditions of Christoph. Columbus, Americus Vespucius? These hodœporicons to remote and fabulous places of the world? To see birds, beasts, and fishes of the sea, spiders, gnats flies, serpents, &c., all creatures set out and truly represented?"*

The book itself is one of those huge folios in which our ancestors so greatly had their delight; books with broad margins, heavy linen paper, good black ink, large type, bound in ponderous oak boards covered with stamped hogskin, and weighing several pounds. †"Scholars of a former

* Burton.
† Disraeli.

age regarded with contempt small books and a common reproach against a man was that he was the author of such." But the very magnitude of a work has often been the occasion of its neglect, as but very few persons have either leisure or inclination to wade through long series of ponderous tomes; a fact only apparent to book publishers within the last one hundred and fifty years. Such sized volumes tempt the reader to cry out as Macaulay did in his celebrated criticism upon Dr. Nares' life of Lord Burleigh.

The learning which gave rise to such works was as weighty, as solid, and as substantial as the volumes themselves. The period in which it flourished was before the day of easy paths to knowledge, compends, abridgments and short cuts; the royal road had not yet been discovered, the quagmires filled up, nor the forests leveled that obstructed the pathway. The consequence was that those who were scholars were more thoroughly and deeply learned than those of the present day. The diffusion of knowledge has seemingly resulted in sciolism; where once the few were educated, the many now are smatterers.

Knowledge is like a powerful stream, whose currents while checked within its banks flows deeply and strongly although silently; but when the obstructions which hem it on each side are removed, when the obstacles to its free dispersion are leveled, it spreads itself over the adjacent country, so that where once a noble river ran, naught now remains except a shallow babbling brook.

Diffusion of knowledge, as it is fashionable to call it in the cant of our day, is unfortunately frequently only a diffusion of ignorance.

On a New Synthesis of Saligenin. *By Wm. H. Greene, M.D.*

(*Read before the American Philosophical Society, January* 16, 1880.)

The method by which I have obtained saligenin synthetically is an application of a general method for the preparation of phenolic derivatives, made known by Reimer and Tiemann. Indeed, since by the reaction of chloroform or of carbon tetrachloride on an alkaline solution of sodium phenate salicylic aldehyde or salicylic acid may be obtained, it may naturally be expected that, under the same circumstances, methylene chloride would yield saligenin, the latter being an oxybenzylic alcohol.

A mixture of 30 grammes of methylene chloride, 30 grammes of phenol, and 40 grammes of sodium hydrate dissolved in 50 grammes of water, was heated in a sealed matrass in a water-bath. The reaction is complete in about six hours, after which the contents of the matrass is neutralized with hydrochloric acid, and agitated with ether, which takes up the saligenin and the excess of phenol. The ethereal solution is decanted, and the ether distilled off; the residue is repeatedly exhausted with boiling water, which takes up the saligenin and leaves the greater part of the phenol undissolved. The aqueous solution is concentrated to a small volume, and the drops of

phenol which separate on cooling are removed. After exposing the residue for some time over sulphuric acid, a crystalline mass is obtained, which is pressed, and recrystallized from boiling water or from alcohol. Pure saligenin is thus obtained.

The quantity of saligenin is by no means in proportion to the quantity of phenol employed, and an alcoholic solution of sodium hydrate was found to yield no better results than an aqueous solution, although the reaction took place more promptly.

Isomeric oxybenzylic alcohols may be, and probably are, formed at the same time, but I have not yet been able to isolate such compounds.

On the Foramina Perforating the Posterior Part of the Squamosal Bone of the Mammalia. By E. D. Cope.

(*Read before the American Philosophical Society, February* 6, 1880.)

The number of perforations of the posterior part of the squamosal bone in the *Mammalia* is considerable, and they have not attracted that attention from anatomists which their importance deserves. As I have found them to be especially valuable in diagnosis, I have thought it might be useful to place on record the manner of their occurrence in various recent genera with whose structure we are more or less familiar in other respects.

The one of these foramina of which some notice has been taken, is the *postglenoid*, which is mentioned by Flower (Osteology of Mammalia) as occurring in the dog and bear, and as absent in the cat. I find five other foramina which usually form the outlets of canals which are connected with the lateral venous sinus. The principal canal extends from the postglenoid foramen upwards and backwards between the os petrosum and the squamosal, and enters the cranial cavity at the superior border of the former. At a point in the parietal bone, often on or very near the squamoso-parietal suture, it issues on the surface again, in the foramen which may be called the *postparietal*. A branch of the canal may take a posterior direction and issue on the occipital face of the skull in the suture between the *ossa petrosum* and *exoccipitale*, forming the *mastoid* foramen. Or a posterior branch may issue in the posterior part of the squamosal bone in a lateral foramen, the *postsquamosal*. In certain Mammals a large foramen perforates the base of the zygomatic process of the squamosal from above, entering the canal after a short course of its own; this I call the *supraglenoid* foramen. Still another inlet to the canal is found in some Mammals, perforating the squamosal below the crest which connects the zygoma with the inion, occupying a position posterior and exterior to the post-

glenoid, and generally looking more downwards than outwards. I call this the *subsquamosal*. These foramina may be arranged in four sets, as follows :

I. Looking downwards ;
Postglenoid.
Subsquamosal.
II. Looking outwards ;
Postsquamosal.
Postparietal.
III. Looking upwards ;
Supraglenoid.
IV. Looking backwards ;
Mastoid.

Some foramina of the same region are not necessarily connected with the *sinus lateralis*. Hyrtl, in his essay* on the arterial system of the *Edentata*, shows that a foramen near to the postsquamosal of the *Tamandua tetradactyla*, gives passage to an "*arteria diploëtica*," which is formed by the junction of the occipital branch of the carotid with an ascending branch of the *temporo-maxillaris* division of the carotid. The *a. diploëtica* issues in a foramen which perforates the parietal bone on the orbital border. These two foramina may be called the *f. diploëticum posterior* and *f. d. anterior*, respectively. The former enters from the fundus of the same small fossa, which is also perforated in its superior portion by the *f. postsquamosale*, the canal from the latter foramen taking the usual vertical direction.

Still another foramen exists, which is, so far as my present knowledge goes, confined to the *Monotremata* and *Marsupialia*. It enters the posterior base of the zygomatic portion of the squamosal, and is directed forwards.

In *Tachyglossus* it passes through the base of the zygoma, issuing in the base of the zygomatic fossa. In the *Marsupialia* it enters a fossa of the squamosal bone, which may or may not be partially filled with cancellous tissue. I call this the *foramen postzygomaticum*.

I now give the results of my observations on the crania of the most important genera which I have observed, one hundred and sixteen in number.†

Monotremata.

Tachyglossus. The only foramina are the *f.f. diploëtica anterior* and *posterior*, and the *postzygomaticum*. The anterior half of the canal connecting the former two has no external wall.

Ornithorhynchus. Postzygomatic large and passing through the zygoma ; postsquamosal large ; no other foramina.

Marsupialia.

The types of this order generally have the postglenoid, and hardly ever have the supraglenoid or postparietal. They are generally distinguished

* Denkschriften Wiener Akademie, 1854, T. III, pl. 1.

† Most of these are preserved in my private collection ; for a few I am indebted to the Museum of the Philadelphia Academy.

by the presence of the subsquamosal, but in *Hypsiprymnus* and *Macropus* this foramen becomes the postsquamosal, through the failure of the postzygomatic crest. It need not be confounded with another foramen also found in these genera, which enters above the *meatus auditorius externus*, and communicates with the tympanic chamber, and which I call the *supratympanic foramen*. The subsquamosal enters the sinous canal, and in *Phascolarctos*, where the postglenoid is wanting, constitutes its only external outlet. The order is further characterized by the presence of the postzygomatic foramen.

Phascolomys; postzygomatic chamber enormous, extending above meatus. No foramina below, except supratympanic; above, a supraglenoid and one or two postglenoids.

Phascolarctos; subsquamosal and postzygomatic only; the latter communicating with an empty chamber.

Macropus and *Hypsiprymnus;* postglenoid, postzygomatic, supratympanic and postsquamosal; the second communicating with a chamber filled with cancelli.

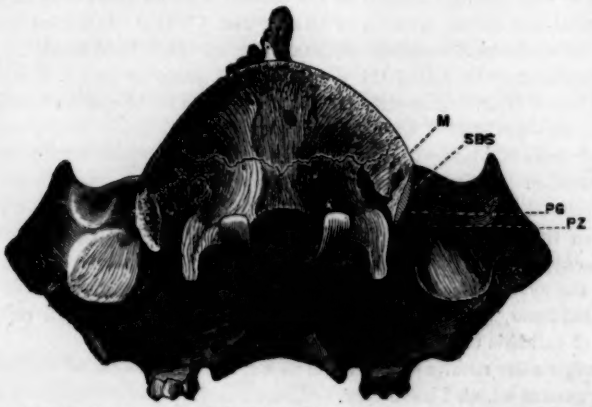


FIG. 1.—Skull of opossum (*Didelphys virginiana*) natural size, posterior view, parts of the right mastoid and squamosal bones removed. M, mastoid foramen; SBS, subsquamosal; PG, postglenoid; PZ, postzygomatic foramen.

Didelphys; postglenoid, postzygomatic, subsquamosal and mastoid; postzygomatic small.

Dasyurus; postglenoid, subsquamosal and probably mastoid. I cannot find a postzygomatic.

Phalangista; postsquamosal and postparietal only; no postzygomatic nor supratympanic.

EDENTATA.

Tamandua; F. f. diploëtica anterior and *posterior*, and postsquamosal only.

Dasypus (6-*cinctus*); postglenoid (large), postsquamosal, mastoid, several postparietals, and a small subsquamosal.

Chlamydophorus; a postglenoid only.

Manis; postzygomatic only.

Megalonyx; postsquamosal and supratympanic; a closed fissure at position of postglenoid. A large foramen below the usual position of mastoid.

Bradypus and *Cholœpus;* no foramina.

Rodentia.

In this order, so far as yet observed, the supraglenoid and postparietal foramina are never present, while the mastoid is rarely, and the subsquamosal is generally, represented. The ridge connecting the zygoma with the inion being weak, the difference between this foramen and the postsquamosal is less marked in this order than in the *Marsupialia*. It is, however, always on the inferior border of the squamosal bone.

Lepus and *Lagomys;* no foramina.

Lagidium; no foramina.

Cercolabes; no foramina.

Lagostomus, Geomys and *Erithizon;* an enormous postglenoid without internal canal.

Capromys, Cœlogenys, Sciurus, Haplodontia, Hesperomys, Mus; postglenoid and postsquamosal only.

Hystrix, Hydrochœrus, Neotoma and *Arvicola;* postglenoid and postsquamosal foramina confluent; no others.

Castor, Cynomys and *Spermophilus;* postglenoid, postsquamosal and mastoid.

Insectivora.

The foramina are very much as in the *Rodentia* in the smaller forms, and as in the *Carnivora* in the larger.

Blarina, Condylura and *Scalops;* postsquamosal only.

Erinaceus; postglenoid and postsquamosal only. *Mystomys* the same, according to Allman's figures.

Centetes; postglenoid, postparietal and mastoid.

Solenodon (from Peters' figures); postglenoid and postparietal.

Chiroptera.

In some members of this order the foramina are, as in many Carnivora, limited to the postglenoid and postparietal.

Scotophilus (*fuscus*); postglenoid, postparietal and mastoid.

Pteropus; postglenoid, subsquamosal and postsquamosal.

Carnivora.

In this order the foramina are few in number, and are very well defined. None of them possess more than three, while the specialized forms, both terrestrial and aquatic, do not possess them.

Trichecus and *Arctocephalus;* no foramina.

Phoca; a rudimental postglenoid.

Ursus, *Arctotherium* and *Hyænodon*; postglenoid, mastoid and postparietal.

Enhydrocyon and *Temnocyon*; postglenoid and postparietal only.

FIG. 2.—*Temnocyon coryphæus* Cope, Lower Miocene of Oregon; one-half natural size. PP, postparietal foramen.

Archælurus, *Dinictis*, *Pogonodon*, *Hoplophoneus* and *Machærodus* (*cerebralis*); postglenoid and postparietal only.

Procyon, *Nasua* and *Bassaris*; postglenoid only.

Canis, *Vulpes* and *Urocyon*; postglenoid only.

Viverra, *Mustela*, *Putorius* and *Mephitis*; postglenoid only.

Felis (*domestica*); sometimes a minute postglenoid only; sometimes none.

Hyæna, *Uncia*, *Cynælurus*; no foramina.

PROSIMIÆ.

Lemur, *Chirogaleus* and *Tarsius*; a postglenoid only.

QUADRUMANA.

Hapale; postglenoid and postsquamosal.

Cebus; postglenoid and postparietal. The latter is on the suture of the parietal and squamosal bones; in *Hapale penicillata* it is entirely within the squamosal bones.

Ateles, *Callithrix*, *Mycetes*, *Semnopithecus* and *Cynocephalus*; no foramina.

Macacus; a small postglenoid.

Troglodytes niger, *gorilla*; a closed fissure, but no foramen postglenoideum.

Homo; no foramina in sixteen North American Indians examined of the Klamath, Bannock, Crow, Sioux and Cheyenne tribes. One postglenoid on one side in a South Australian. One or two mastoids are more usual, being found in a good many specimens of all races. They are rarest in Hottentot negroes.

CETACEA.

Balæna, *Beluga* and *Monodon*; no foramina.

SIRENIA.

Halicore and *Manatus*; a huge mastoid only.

HYRACOIDEA.

Hyrax; no foramina.

PROBOSCIDIA.

Elephas; no foramina.

PERISSODACTYLA.

In this order the number of the foramina ranges from very few to many.

FIG. 3.—*Aphelops megalodus* Cope, Loup Fork of Colorado; one-sixth natural size; showing postparietal foramen.

Rhinocerus, Aphelops; postparietal only.

FIG. 4.

FIG. 5.

Skulls of *Aphelops megalodus* (Fig. 4) and *A. fossiger* (Fig. 5) from behind; one-sixth natural size; showing absence of mastoid foramen.

Tapirus; postparietal and a huge mastoid.

Anchitherium, Hippotherium, Protohippus and *Equus;* postparietal, postsquamosal, postglenoid and supraglenoid. In the last three genera

the vessel issuing from the postsquamosal, grooves the petrous bone, leaving it at a point near that usually occupied by the mastoid foramen. In the second and last genera, and probably in the third, the sinous canal is protected by a bony crest in front, throughout its entire length.

Artiodactyla.

Great diversities are found in this order, especially between the suilline and ruminant divisions. In the former, with the exception of the *Hippopotamidæ*, there are no foramina; in the *Ruminantia* they are more numerous than in any other order of the class. The *Ruminantia* are, like the equine *Perissodactyla*, characterized by the presence of the supraglenoid foramen; to this the *Camelidæ* and some others add the mastoid. The *Tragulina* must be excepted from this rule, for they have nothing but the postglenoid.

Omnivora.

Sus, *Dicotyles* and *Phacochœrus*; no foramina.

Hippopotamus and *Chœropsis*; postglenoid, postsquamosal, mastoid and a rudimental supraglenoid.

Ruminantia.

Tragulus; postglenoid only.

Oreodon; postparietal and mastoid. In one specimen of *O. culbertsoni* from Colorado, I find a minute supraglenoid on each side; in other specimens it is wanting.

Poëbrotherium; postparietal, postglenoid; mastoid; a small supraglenoid.

Fig. 6.—Skull of *Procamelus occidentalis* Leidy, Loup Fork of New Mexico; one-fourth natural size; showing supraglenoid foramen, SPG.

Procamelus, *Camelus*, *Auchenia*; postglenoid, supraglenoid and mastoid.

Bos; postglenoid and supraglenoid only.

Antilocapra; postparietal, postglenoid, mastoid, and a large supraglenoid.

Giraffa; postglenoid, supraglenoid, postsquamosal and mastoid.

Oreas, *Ovis*, *Cervus*; postglenoid, supraglenoid, postsquamosal, postparietal and mastoid.

From the preceding the following conclusions may be derived :

(1) The sinous foramina furnish valuable diagnostic characters, and may, with proper limitation, be used in systematic definition.

(2) The primitive condition of the various mammalian orders appears to have been the possession of a limited number of these foramina.

(3) The monotreme-marsupial line have developed a number of foramina in their own special way.

(4) The *Rodentia* have chiefly developed those of the inferior part of the squamosal bone, if any.

(5) The *Carnivora* commenced with but few foramina, and have obliterated these on attaining their highest development.

(6) The history of the *Quadrumana* is identical with that of the *Carnivora*.

(7) The *Perissodactyla* present very few foramina in the lowest forms, and did not increase them in the line of the *Rhinocerida*. In the line of the horses an increase in their number appeared early in geologic time, and is fully maintained in the existing species.

(8) In the Omnivorous division of the *Artiodactyla*, time has obliterated all the sinous foramina. In the Camels an increased number was apparent at the same geologic period as in the history of the horses (White River or Lowest Miocene), and has been maintained ever since ; while the existing *Pecora* present a larger number of the foramina than any of the class of *Mammalia*.

The only relation between these structures and the habits of the species concerned that can now be traced is, that the largest number of the foramina is found in the specialized vegetable feeders, while the smallest number is found in omnivorous forms.

I now give a synopsis of the distribution of the sinous foramina according to the foramina themselves. The *f. f. diploëtica*, *postzygomatica* and *supratympanicum* are not included, as their existence is restricted to the few types already mentioned.

I. No foramina.
Homo, Troglodytes, Cynocephalus, Semnopithecus, Mycetes, Callithrix, Ateles.
Uncia, Hyæna, Arctocephalus, Trichecus.
Elephas, Hyrax ;
Sus, Phacochœrus, Dicotyles.
Lepus, Lagidium, Cercolabes.
Cholœpus; Bradypus.

II. Postglenoid only.

a. Rudimental.
Felis ; Phoca.

aa. Developed.
Chlamydophorus.
Lemur, Chirogaleus, Tarsius ;
Macacus.

Mustela, Putorius, Mephitis; Canis. Vulpes, Urocyon; Viverra. Procyon, Nasua, Bassaris.
Tragulus.

aaa. Enormous.
Lagostomus and *Geomys.*

III. Subsquamosal only.
Phascolarctos.

IV. Postsquamosal only.
Ornithorhyncus, Tamandua, Blarina, Condylura, Scalops.

V. Postparietal only.
Rhinocerus, Aphelops.

VI. Mastoid only.
Halicore, Manatus.

VII. Postglenoid and subsquamosal only.
Hystrix, Hydrochœrus, Capromys, Cœlogenys, Sciurus, Haplodontia, Neotoma, Hesperomys, Mus, Arvicola.

VIII. Postglenoid and postsquamosal only.
Erinaceus.
Macropus, Hypsiprymnus.
Hapale.

IX. Postglenoid and postparietal.
Chiroptera sp.
Temnocyon, Enhydrocyon;
Archælurus, Dinictis, Pogonodon, Hoplophoneus, Machærodus.
Cebus.

X. Mastoid and postparietal.

a. Mastoid small.
Oreodon.

aa. Mastoid enormous.
Tapirus.

XI. Mastoid, postglenoid and postsquamosal.
Castor, Cynomys, Spermophilus.

XII. Mastoid, postglenoid and subsquamosal.
Dasyurus, Didelphys.

XIII. Mastoid, postglenoid and postparietal.
Scotophilus (*fuscus*).
Centetes.
Hyænodon, Ursus, Arctotherium;

XIV. Supraglenoid and postsquamosal only.
Phascolomys.

XV. Supraglenoid and postglenoid only.
Bos.

XVI. Supraglenoid, postglenoid and mastoid.
Procamelus, Camelus, Auchenia.

XVII. Supraglenoid, postglenoid, mastoid, postparietal.

a. Supraglenoid small.
Poëbrotherium.

aa. Supraglenoid large.
Antilocapra.

XVIII. Supraglenoid, postglenoid, mastoid and postsquamosal.
a. Supraglenoid small.
Hippopotamus, Chœropsis.
aa. Supraglenoid large.
Giraffa.

XIX. Supraglenoid, postglenoid, postparietal and postsquamosal.
a. Supraglenoid small; mastoid not grooved.
Anchitherium.
β. Supraglenoid large, mastoid grooved.
Hippotherium, Protohippus, Equus.

XX. Supraglenoid, postglenoid, postparietal, postsquamosal and mastoid.
Cervus, Oreas, Ovis.

Biographical Notice of Professor Joseph Henry. By Fairman Rogers.

(*Read before the American Philosophical Society, February* 20, 1880.)

The admirable memoir of Prof. Joseph Henry, prepared by Mr. William B. Taylor, and read before the Philosophical Society of Washington, October 26, 1878, is so exhaustive both as to his scientific labors and the incidents of his life that little can be added to it until at some future time a biographer will undertake the preparation of a more voluminous life and letters.

As to his scientific career, the memoir deals principally with his earlier work as being more directly personal, and the results of his own manipulation and experiment, while his later days were devoted to the direction and coördination of the work of others.

Regret has frequently been expressed by the scientific friends of Prof. Henry, that his acceptance of the Secretaryship of the Smithsonian, and his devotion to the interests of that Institution had withdrawn him from those lines of original research, in which he shone so conspicuously, and while these regrets are perhaps well-founded, it is a question whether he could possibly have been of more value to science under any circumstances other than those in which this later part of his life was passed.

In his position his influence upon American Science was great and varied. He was a constant and shining example before the eyes of the younger scientific men of an unselfish devotion to the interests of science for itself, and not for self aggrandizement. Honest in the widest and deepest sense of the word, he never permitted expediency, self-interest or passion to interfere with the search for truth, and his clear and simple expressions on such subjects put it out of the power of those who consulted him to do otherwise than follow the example which he set them.

Filling for years a position in which, without violating any of the principles which many, nay, most men consider quite sufficient for their moral guidance, he might have used his knowledge for the furtherance of his own selfish ends, he never swerved for an instant from his determination to examine and decide all matters from the purely scientific point of view, unbiassed by any considerations as to how his decisions might affect the interests of any one, and the hosts of inventors and projectors who are constantly hovering around Government headquarters found him a sentinel whom it was impossible to cajole or to pass without that countersign of true worthiness which his trained mind was quick to recognize.

While he no doubt, had he remained in his laboratory, would have added year after year to the knowledge of the world by original research, he did so much in his prominent position to encourage and assist such work by others, that it may be fairly presumed that the results were equally good. While there are many men who in the solitude of the laboratory can carry on important investigations, there are few who join to an accurate scientific training the ability to impress and to direct men who are their scientific equals, the lofty incorruptibility of character, and the clear-sighted power of grasping a subject which he possessed.

In this respect as well as by his official position he much resembled his friend Alexander Dallas Bache with whom he was intimately associated for the many years during which they both lived in Washington.

Brought into continual personal contact with the active scientific men of the day, they exerted an incalculable effect upon what we might call the scientific morals of the younger generation, and always trod themselves, the paths which alone lead to honor.

Single minded and steadfast in their purposes, they would listen to no projects which had about them the taint of selfishness or corruption, and the man who met them with any project which would not bear the full light of day soon felt that he had made a grievous mistake, and retreated in confusion.

In writing thus, I do not mean that Prof. Henry frowned only on those projects which the average sentiment characterizes as dishonest, that was his clear and evident duty, but he also taught that scientific work had for its object the development of truth, and that all the petty considerations of claims of priority, and the jealousies which so often embitter the relations of scientific men were unreal and unimportant, purely secondary matters.

It is somewhat doubtful whether any one can occupy again a position in the American scientific world exactly similar to his. Commencing his scientific career at a time when it was quite possible for a great man to know the whole range of the physical sciences in a way more or less complete, he was looked up to by all men working in those fields as an acknowledged authority, and his influence was thus very extensive. Now these fields have become so large and varied that it is hardly possible for any one to become more than a specialist, and the power of coördination

which Prof. Henry in common with Bache and Agassiz, exercised is gone with them, and must perhaps now be concentrated in Academies and Societies.

Prof. Henry's closest connection with the American Philosophical Society was during his residence at Princeton, from the year 1832 to 1846, during which period he made constant communications to the Society, and attended its meetings regularly, forming and cementing those friendships with many Philadelphians which lasted through his life. This was the time of his greatest activity in original work, and as Faraday, in England, Biot and Becquerel, in France, and Riess, in Germany, were engaged in parallel investigations of the greatest importance, the period was one of the most interesting in the annals of science.

Upon his election, in 1846, as head of the Smithsonian Institution, his opportunities for direct private investigation in his own laboratory ceased, but he had improved facilities for controlling extensive investigations through correspondents, which added largely to scientific knowledge, and some of his later personal researches, such as those relating to lighthouse oils and to sound signals, were of the greatest importance.

Elected President of the National Academy of Sciences, in 1868, after the death of its first President, Prof. Bache, he exercised in its affairs the same strong, sensible, quiet influence that characterized his usual action, and his last formal connection with it, only a few weeks before his death, was marked by two incidents, in themselves of much interest.

His waning powers and several sharp attacks of illness had warned him that his life was drawing towards its close, and one of his intimate friends, with whom he sometimes took counsel about his family affairs, found that he was troubled by the fear that his family might suffer from straightened circumstances after his death. Without giving him the least intimation of what was intended, a fund of forty thousand dollars, in one thousand dollar subscriptions, was quickly made up among his friends and admirers in several Eastern cities, principally in Philadelphia, and placed in trust for the benefit of his wife and children during their lives, with the proviso that after their death it should go to the National Academy of Sciences, and form "The Joseph Henry Fund," the interest to be applied to assisting investigators in original research.

Nothing could have been more pleasant than the way in which Prof. Henry took this compliment. He appreciated exactly the spirit in which the movement was made, and said that the only source of trouble in his mind was now removed. He frequently referred to it, and enjoyed drawing a parallel between his life and that of his intimate friend, Bache, remarking that they had worked together, had occupied high scientific positions under government together, had both been Presidents of the Academy, and that now the chain would be unbroken, for he would leave behind him, in the hands of that Academy "The Joseph Henry Fund," as Bache had left "The Bache Fund."

The presentation of this fund to the Academy formed a conspicuous part

of the business proceedings of the Session of April, 1878, and the President's address, which was his last formal communication to that body, touched in the most feeling manner upon the compliment paid to him.

The other incident was the exhibition to the Academy, by Mr. Edison, through special invitation, of the phonograph, and of a number of improvements upon the telephone and kindred instruments. A private exhibition of them was made in Prof. Henry's private rooms in the Smithsonian Institution, and nothing could have been more interesting than the spectacle of the famous old physicist studying with the most intense interest and the clearest appreciation, the very latest developments of the sciences to which he had devoted his life, and the application of those investigations, in many of which he had led the world fifty years before.

He felt, and those about him felt, that it was probably the last time that he would have any direct connection with the active science of the world, and so it proved; for, within less than four weeks, his friends were called upon to mourn his death.

The funeral services of Prof. Henry were the occasion of a large gathering of the scientific men of the country, and of others who, prominent in their respective offices, admired the pure spirit which had passed for so many years unscathed by the breath of scandal, through the temptations of official life; and, on a sunny May afternoon, his remains were deposited in the beautiful cemetery which overlooks the city of Washington, in which he spent so many years, full of honor.

Within a year of his death, the Congress of the United States paid to the memory of Prof. Henry its highest compliment. Both Houses passed on the 10th of December, 1878, the following resolution: "That the Congress of the United States will take part in the services to be observed on Thursday evening, January 16, 1879, in honor of the memory of Joseph Henry, late Secretary of the Smithsonian Institution, under the auspices of the Regents thereof, and for that purpose the Senators and Members will assemble on that evening in the Hall of the House of Representatives, the Vice-President of the United States, supported by the Speaker of the House, to preside on that occasion."

The exercises which were held in a crowded auditorium, consisted in an opening prayer by Dr. McCosh, of Princeton College, and addresses by Senator Hannibal Hamlin, Senator R. E. Withers, Prof. Asa Gray, Prof. William B. Rogers, Representative James A. Garfield, Representative S. S. Cox, and General W. T. Sherman with the concluding prayer by the Rev. Dr. Sunderland, Chaplain of the Senate.

With this mention of such a fitting tribute to his worth, and to the estimation in which he was held by his fellow-men, our short memoir of Prof. Joseph Henry ends.

THE TIMUCUA LANGUAGE.

By Albert S. Gatschet.

(*Read before the American Philosophical Society, February* 20, 1880, *as a third sequel to the articles on this subject read April* 6, 1877, *and April* 5, 1878.)

This third article on the Floridian language once spoken by the Timucua or Atimoke people is herewith presented to those interested in linguistics, with the remark of the author, that all his attempts to connect it by its radical elements with some other language spoken in the neighborhood of its native soil have proved infructuous, and that therefore he regards it as constituting a linguistic family for itself. The position of the author as a linguist of Prof. J. W. Powell's U. S. Bureau of Ethnology, Washington, D. C., has materially facilitated his researches upon the idiom, and any further notice bearing upon the history, ethnography and language of this remarkable nation, the last remnants of which are perhaps not yet extinct, will be received with thanks by the author.

This article subdivides itself into the following portions: Historic Remarks, Ethnographic Remarks, Bibliography, Radical Affinities, Dialects, Grammatic Notes and Selected Texts. Among the texts a missive sent in 1688 by the Timucua chiefs to the King of Spain will be read with much interest.

Historic Remarks.

Our historic information about the Indians of Florida *speaking the Timucua language* is very fragmentary up to the period of the publication of René de Laudonnière's report on his expeditions to that country, or, as he calls them rather unassumingly, "Voyages." His account treats of no other American people but of this, for Florida was the only portion of this continent of which he possessed a special knowledge. From the reports of the chroniclers of the expedition of De Soto (1539–43) we can gather the fact that this race extended across the whole northern part of the Floridian peninsula, for they mention proper names of persons and places on its western coast, which can be explained through no other language but that of the Timucua.

Modern research has proved that the dialects of the Indians inhabiting the northern part of the Floridian peninsula belong to a linguistic family *differing radically* from that of the Maskoki, Yuchi, Cheroki and Algónkin. But the early explorers were not aware of this fact, or at least they did not put it in evidence. In those times not even instructed people could appreciate the enormous ethnologic importance of the difference of linguistic stocks, and had only a vague idea of linguistic classification. The disparateness of linguistic families means early *local* distance of the tribes or nations speaking them, and those who have paid some attention to these studies, know that these linguistic differences must go back into an epoch remote from ours by fifty or by a hundred thousand years. Thus the differ-

ence of linguistic families proves, and is associated with racial difference. But racial difference is not always associated with a disparateness of linguistic family, for it is recorded that certain individuals, tribes and nations have, in the course of time, been prevailed upon to adopt the idioms of neighboring populations, especially when conquered by them.

Although the method, how to infer a difference of race from a thorough, radical disparateness of language was above the conception even of the most learned men of the sixteenth century, we see that these as well as the common adventurers who flooded the islands and coasts of America were close observers of the ethnographic peculiarities of the tribes they visited. Their records leave us in the dark concerning the languages spoken by the Teqestas and Calos on the southern extremity of Florida; we cannot gather from them whether Caribs, Western or Northern Indians were settled in the peninsula at the time of their visit. But they transmit us many peculiar traits and customs, from which they seem to have inferred that all Southern Indians of the Gulf States belonged to one stock.

Our present knowledge of Timucua shows that it stands in no radical connection with the *Galibi dialects* of South America (Arowak, Cumanagota, Chaymas, etc.), nor with the extinct Galibi idioms of the West Indies (Eyeri, Taino, Lucayo, etc.), nor with the Carib on the coast of Honduras. We must therefore discountenance, in some degree, the far-going speculations concerning Carib colonies, and their influence on the Indians in the Apalache country, indulged in by Hervas, Catalogo I, pag. 386 &c., though seafaring men of this nation may have temporarily settled on that coast. Hervas quotes the following terms from Bristock: "Palabras de los Apalachinos que tienen de los caribes: buottou *maza*, taumalí *guisado*, banaré *amigo familiar*, etotou *enemigo*, allouha *arco*, allouani *flechas*, taonabo *lago, estanque*, mabouya *espiritu maligno*, akarnboue *alma humana* y innumerables palabras de cosas curiosas y raras, comunes á los caribes de las Antillas."* Pag. 386: "Las provincias (apalaches) de Amana y Matibue, en donde hay muchas familias de caribes, tienen muchas palabras del antiguo idioma *caribe*."

René de Laudonnière's report, from which Hakluyt made his English and Théodore de Bry his Latin translation, is dated 1586, and bears the following title:

L'HISTOIRE | NOTABLE DE LA FLO | RIDE SITUEE ES INDES | Occidentales, contenant les trois voyages faits en icelle par certains Capitaines & Pilotes Français, descrits par le Capitaine Laudonniere, qui y a commandé l'espace d'vn an trois moys: à laquelle a esté adiousté vn quatriesme voyage fait par le Capitaine Gourgues.

Mise en lumiere par M. Basanier, gentil-homme François Mathematicien.

(Vignette: Bellerophon and the chimera.)

* Most of these terms can be identified with Carib words once in use on the island of Guadeloupe, etc. cf. Breton, Dict.; Brinton, Notes on the Fl. peninsula, pag. 96–98.

A Paris, Chez Guillaume Auuray, ruë sainct Iean de Beauuais, au Bellerophon couronné. MDLXXXVI. AVEC PRIVILEGE DV ROY.

gr. 12mo, 124 leaves, numbered recto only.

To give a historic sketch of the various vicissitudes of the French adventuring soldiers who arrived in Northeastern Florida on June 22, 1564, and established Charlefort or Fort St. Charles (arx Carolana) on the southern shore of the St. John's River, is a task quite foreign to my purpose. My inquiries on the Timucua have prevailingly linguistic tendencies; hence our attention will be solely occupied by gathering from the above, and other sources, notices on the social status, in which the explorers found the people of the Atimoqua, and by the information which can be made available for linguistic science.

In the countries drained by the St. John's River and its tributaries René de Laudonnière heard of the existence of *five paracusi*, and some of them ruled over a considerable number of Indian chiefs and their towns. These five paracusi were called Saturiwa, Holata Utina, Potanu, Onethcaqua and Hostaqua.

Saturiwa and his son Athore resided on the Atlantic coast, south of the outlet of St. John's River, and controlled thirty sub-chiefs, while the Holata Utina, or as De Laudonnière calls him in French orthography, "Olata Ouae Utina," ruled over forty chiefs and their towns further inland. The map added by Theodor de Bry to his pictorial description of these "Voyages" places the seat of the Utina east of some large inland forest, west of the St. John's River, and there are reasons for locating his seat near Lake St. George, a sheet of water formed by the St. John's River in its middle course. That map locates the town of Timoga, which belonged to the domain of this head chief, upon the eastern shore of the St. John, and De Laudonnière's text places it twenty leagues from Saturiwa's seat. The Timagoa people were the most inveterate and implacable enemies of Saturiwa's warriors; and when a war was impending between Saturiwa and the Timagoa, because the former had obtained some silver by force from the latter, De Laudonnière offered his military assistance to Saturiwa. He thereby hoped to obtain trustworthy information on the countries, where the silver, as well as the gold of which some of their ornaments were made, was obtained; constant rumors pointed to the "Apalatci mountains" as to the source of these precious commodities. Both sexes wore various ornaments made of gold, and most conspicuous were the disk-shaped gold pieces worn around their loins at dances and on other solemn occasions.

Potanu, written Potauou by De Laudonnière, was twenty-five leagues from Utina; he gives this name to a chief, Pareja gives it to a province in the interior.* This chief controlled an upland tract of country; in this tract was found the hard slate stone, from which the people made wedges to cleave wood and to finish their canoes after they had burnt out a cavity

* Personal names are frequently confounded in De Laudonnière's and other narratives with local Timucua names, and vice versa.

in the logs beforehand. To deprive Potanu of his slate quarries, the Olata Utina warred against him, and an officer of De Laudonnière assisted him in putting his antagonist to flight.

The home of Onethcaqua is located "near the high mountains"; the map reads: Onathcaqua. Hostaqua, Houstaqua is a settlement located by the map a short distance from Onathcaqua, and we are told that the people of these two communities (De Laudonnière calls head-chiefs by these names) painted their faces black, while the people of Molloua (Mulua) used red paint for this purpose.

It is probable that these five paracusi were nothing but *head-chiefs* of tribal confederacies, and that the real power was not in their hands, but in those of their sub-chiefs or holata. Head-chiefs and chiefs surrounded themselves with considerable ceremonial and pomp, and probably on this account the chroniclers call them *kings*; but some kind of etiquette surrounded all chiefs throughout the territories near the Gulf of Mexico, and that the Timucua people enjoyed a sort of democratic rule is shown by the election of a new chief by the warriors. From Pareja's writings alone, which were composed fifty years later, we would certainly be led to assume that the Timucua people was ruled rather despotically. On many points the narrative of the French captain is neither precise nor satisfactory; we learn nothing positive about the territorial extent of the settlements of the Timucua race, nor about the national name by which they called themselves. His book goes to show that Timoga, Timagoa was the name of *one* town, village or chieftaincy only; in later times it was extended over several chieftaincies only by the circumstance that the Indians of this place were among the first christianized, and that missionaries composed books in *their* dialect only. The same thing has occurred with the Mutsun of San Juan Bautista, California.

Some of the French explorers seem to have reached the locality where *gold* was obtained in the sand of the rivers and brooks, but the result being not satisfactory, they soon returned to Fort St. Charles.* When they began to suffer of famine, the Indians showed to them their natural treacherous disposition and scoffed them for their misery, but never attacked them, protected as they were by an insular fort armed with cannons. Two Spaniards were liberated by them, who told them about the existence of the Calos "kingdom" at the southern extremity of the peninsula; one of them had been despatched as a messenger by the Calos chief to chief Oathchaqua, a four or five days' journey north of Calos. Half way he saw the island Serropé in a fresh water lake of the same name.

Fontanedo mentions forty towns or settlements of the *Calos*, or *Callos*

* Gold was called by them sieroa pira (pira, *red, yellow*). The chronicler Fontanedo speaks of the "mines of Onogatano, situated in the snow-clad mountains of Onogatano, the most distant possessions of Abolachi;" Mem. p. 32. Cf.: "The precious metals possessed by the early Floridian Indians," pag. 199–202 (Appendix III) of *Brinton*, Notes on the Flor. Peninsula. Brinton thinks that the Timucua were probably acquainted with the auriferous gulches of the Apalachian ridge in Georgia and the Carolinas.

Indians, who held the south-western portion of the peninsula (Brinton, *Notes*, p. 113). Among twenty of their number, Comachica and Cala-obe are probably belonging to the Timucua language (hica, land, country; kála-abo, fruit-stalk or fruit-tree); the town of Tampa has a Maskoki name: itímpi *near, close to it.* Some of these towns were located on Lucayo Islands (the Keys?), and four in the land of the Tocobayo, on Lake Mayaimi. Near Manatee, Brinton found a small lake called Lake Mayaco, a name not altogether unlike Mayaimi; but Lake Mayaimi is described by the chroniclers as being of huge proportions. Sarasota Bay and Island, Manatee Co., on the western coast, seems to be a Timucua name, but the majority of the present Indian names of localities found on maps of the peninsular part of the State are Seminole, an idiom differing but very little from the Creek, of the Maskoki family. Thus Welaka, a town on St. John's River, Putnam Co., is the "great water," o-íwa thláko, contracted into withláko; this was or is still the Seminole name for the St. John's River, and is interpreted by some writer: "river of many lakes." The French called the St. John's River la Rivière Mai, because entered on May 1st by their vessels; the Spaniards named it Rio de San Mateo, Rio Picolata, Rio de San Juan.

South of Cape Cañaveral, the country along the Atlantic Coast was called by the Spaniards, who had a post there, the "Province of Tequesta." The northern portion of this section of land was called in later epochs Ais, Ays, Is, and Santa Lucia by the Spaniards. *Ais* is interpreted by aïsa, *deer*, a term not belonging to the Timucua language, but identifiable with itcho, *deer*, in Seminole, or itchi, itche in Hitchiti and Mikasuke.

The *work of christianizing* the Florida Indians began with the establishment of a permanent Spanish garrison at St. Augustine by Adelantado Pedro Menendez de Aviles, in 1564. The padres mostly went to the southern portions of the land; two were sent to the "Calusas" in 1567, and 1568 ten others arrived, who dispersed themselves in various directions. Padre Antonio Sedeño settled in the island of Guale (Mary's, Santa Maria, now Amelia Island) and was the first to compose there a catechism and a grammar of some North American language not specified.

After Menendez had returned to Spain in 1567, the French Huguenot leader De Gourgues, allied with the paracusi Saturiwa, demolished the most important Spanish forts in the same year, and the Spanish missionaries met with the most cruel reverses. Padre Rogel returned from the Calos country, disgusted with his ill-success, and went to San Felipe, a Spanish coast settlement in the "Province of Orista," north of the Savannah River, but did not remain long. Coava, chief of an inland country named Axacán, one hundred and fifty leagues from San Augustine, put to death all the apostolic missionaries sent among his people. The English captain Francis Drake destroyed San Augustine in 1586.

In 1592 twelve Franciscan padres were sent to this bloody field of Catholic martyrdom, and two years after this, twenty "mission houses" were in existence. But the indomitable spirit of the aborigines could not tolerate

any priestly interference with their own customs and traditions. They murdered in cold blood Pedro de Corpa, missionary at Tolemaro, near the mouth of St. Mary's river, killed the missionaries at Topiqui, Asao, Ospo and Assopo, all on Guale island, and destroyed their churches and other mission establishments.

In 1612, the "Custodia" of the eleven convents of Florida was erected into an independent ecclesiastic "Provincia de Santa Elena," the principal house being at Havana; thirty-two Franciscan priests were sent there (1612–13) to found missions, and in 1616 their number was increased by twelve others.

In 1638 a war took place against the Apalache Indians. The civil administration of the province was from 1655 to 1675 in the hands of Governor Don Diego de Rebollado, "Capitan-General." His successor from 1675 to 1680 was Don Juan Hita de Salaçar, who was followed by Don Juan Marquez Cabrera. Twenty-four Franciscans were disembarked in 1676 to christianize the natives. A town Timucua is, not long after this, recorded at New Smyrna, Volusia Co, on the Atlantic coast, about ninety miles south of San Augustine.

In 1687, Governor Juan Marquez attempted to remove some Indian tribes of Florida, Apalachis, etc., to the West Indian Islands. Upon this a revolt broke out in San Felipe, San Simon, Santa Catalina, Sapala, Tupichihasao, Obaldaquini and some other towns; the natives emigrated to Georgia, or took refuge in the forests. This revolt does not seem to have extended over those pueblos or towns who sent the letter, printed below, to King Charles II, of Spain († 1700), and they were evidently well satisfied with their present governor.

It was perhaps a consequence of this revolt that, in 1687, some Yamassi Indians, living under Spanish rule, left their country for the South, invaded the mission of Santa Catalina, in the province of Timucua, pillaged the church and convent of San Francisco by removing its plate and vestments, burnt the town of Timucua, killed many converted Indians, while others were brought as slaves to Santa Elena. The reason given by the Yamassis for this unprecedented massacre was that they were disgusted with the rule of the Franciscans, and tried to put an end to it. English instigations were supposed to be at the bottom.

The English colonists of Georgia and the Carolinas, jealous of the Spanish and their power, began from 1702 a series of inroads into Florida, which lasted for half a century, and entailed much misery on the Spanish Indians. Col. Daniels, who led the land force of Governor Moore's army in 1702, took St. Augustine, and met, as far as known, with no resistance. These incursions lasted until 1706, and an inroad of the Alibamu Indians occurred in 1705. Further English inroads are recorded for the years 1719, 1727, 1736, 1740 and 1745.

It is not altogether impossible that some Timucua Indians survive at the present time, for the Pueblo de los Atimucas, on the Muskito lagoon, Volusia Co., has subsisted long after the beginning of the English raids.

Either the Atlantic coast or the borders of the interior fresh-water lakes, or the Seminole settlements, Fla., might still harbor some of the race, though little hope is to be entertained that their ancient vocalic language may still be heard among them.

Ethnographic Remarks Concerning the Timucua People.

Not only for the history of the Floridians, but also for their ethnography the report of René de Laudonnière is of the greatest value. In the small extent of territory which he saw, the manners and customs were probably the same everywhere, on the coast and in the interior; but further to the west, among the Apalache, Hitchiti and Creeks, they must have differed not inconsiderably. The artist Jacques le Moyne de Morgues accompanied the captain on his expeditions inland, and with his skilful pencil reproduced most tastefully what he had observed among the red men of the plains and forests. These sketches do not seem to be historically faithful in every respect, for striking pictorial effect often seems more desirable to artists than historic truth; but taken as a whole, they give us a vivid picture of the reality of life among the Timucua. They were published in Theodor de Bry's collection of pictorial voyages, vol. II, with *Latin* text at the lower margin (Brevis Narratio; Francofurti ad Moenum, 1598, fol.). Alb. J. Pickett, History of Alabama, Charleston, 1851 (2 vols., 12mo.), has reproduced several of these drawings, together with extracts from De Laudonnière; but he wrongly supposes that LeMoyne's pictures represent the appearance and customs of the Southern Indians in general. Neither he nor Fairbanks, nor any other southern writer speaks of the Timucua as a *distinct* race.

Condensed from De Laudonnière, Pareja and other sources, I present the following short sketch of what appeared to me the most characteristic of all the Timucua customs and peculiarities:

Men and women generally went nude. Their *bodies* were well proportioned, the men were of a brown-olive color, tall stature and without apparent deformities. The majority of men tattooed themselves in very artistic devices on the arms and thighs, and to judge from Le Moyne's pictures, the chiefs at least were tattooed over the whole body. They trussed up their long black hair in a bunch resting on their head, and covered their privates with a well-dressed deerskin. Women wore the hair long, reaching down to the hips, but on losing their husbands they cut their hair off to its root, and did not remarry before it had grown again to reach the shoulders. Both sexes were in the habit of wearing their finger nails long. The custom of pressing the heads of infants is not mentioned.*

*This custom prevailed largely among the Chá'hta, who were called Flatheads on that account. The German anatomist, A. Ecker, has lately examined twenty skulls excavated on the western coast of Florida, and published the result in the Brunswick "*Archiv für Anthropologie*," vol. X (1878), page 201-14, under the heading: "Zur Kenntniss des Körperbaues früherer Einwonner der Halbinsel Florida." He thinks that a portion of them was artificially altered and deformed, but that they belonged to a race similar or identical to that encountered by the first Spanish explorers; he further believes, that the people which accumulated the shell-heaps which are so frequent on the Floridian shore-line differed from the above, and perhaps belonged to the Carib stock.

Women were seen to climb the highest trees with agility, and to swim over broad rivers with children on their backs. When they became pregnant, they (and the Creek women) kept away from their husbands, and during their periods were careful to eat certain kinds of nutriment only; they drank blood to render their sucking children stronger and healthier. Chiefs had one legitimate wife, whose children alone could inherit them, and one or two concubines. The first-born males in the tribe were sacrificed to the chief, under solemn ceremonies.

Most Indians were found to be diseased by the "pox," for they were exceedingly fond of the other sex, calling their female friends "daughters of the sun." Pederasty was not unfrequent, and the French noticed quite a number of "hermaphrodites," who were very strong in body, and used as load-carriers, especially on war expeditions. The Indians showed a feeling of repugnance towards them.

The Timucua declared *war* by sticking a number of arrows into the ground, fliers up, in close vicinity to the enemy's camp. This was done with the utmost secrecy the night before the attack, and locks of human hair were seen dangling from the end of the arrows. The chiefs led the warriors on the war-path, club, arrows and bow in hand; when the fight had begun, they placed themselves in the centre of the combatants, and their usual mode of attack was to surprise the enemy, as is done by all Indians. They fought valiantly and impetuously, when compelled to fight openly; their weapons were spears, clubs, bow and arrows, and a small target hung on the chest. Their arrows were headed with stones and fishbones, both being worked quite handsomely and carefully. The warriors put to death all men captured (though exceptions to this are recorded), cut off their arms above the elbow, and their legs above the knee, took their scalps, and ran an arrow into their anus, leaving them in this condition on the battle-field. The scalps and sometimes the cut-off limbs were brought to camp, stuck on poles which they connected with garlands, and during the scalp dance, which lasted three days and nights, the most revolting orgies were gone through. The oldest of their women were compelled to join hands in the maddening dance; the scalps of the slain were smoked over a fire, while praises were sung to the sun for the victory obtained. Women and children of the enemy were kept as slaves. Warriors ornamented their heads with all kinds of feathers, leaves and plants, like the Aztecs and Mayas, or drew the head or skin of some wild animal over their foreheads, to protect the head.

When *hunting game* they hid themselves in deer skins, and thus shot their game by decoy. The various superstitions of hunters are contained in Pareja's queries. He also speaks of their barbacoas or provision houses, and Le Moyne's picture shows that these were low palisade huts, roofed over, and having only one issue. In the maize gathering season, the whole crop was carried to these *barns*, and subsequently it was portioned out to every man according to his quality. The watchmen of these barns, when found to be neglectful of their duties, were executed by a heavy blow on the head with a war-club.

As one of the pastimes of their young men is mentioned the throwing of balls against a square mat made of bulrush reeds, hanging from a pole 8–9 fathoms high; the one who succeeded in making the mat come down, was winner in the game.

At the *death* of a holata or *chief*, men and women cut their hair off to half length, and a thorough abstention from food was ordered for three days; the deceased was buried ceremoniously, on the top of a terrace-mound, a smaller mound erected over his grave, and a large conch or marine shell, which had been his drinking cup, placed over this monticule. The conch was then surrounded by a circle of arrows stuck perpendicularly into the soil, at two or three feet distance from the conch.

In a people which believes in the power of *conjurers* over ghosts and spirits, the influence of the bewitcher or shaman must be necessarily immense. From Pareja's queries we gather the fact that mostly old men, *naribua*, were acting as conjurers; they consecrated the arrows before a hunting party left for the woods, and when the game did not expire from the first shots, they prayed over another arrow which would certainly finish it; they produced rain, restored lost objects to their owners, spoke their benedictions over corn-cribs and new fish weirs, over a catch of fish and over baskets of recently gathered fruits. They treated the sick with incantations and physicked them with herbs; they sometimes cured them halfways only to exact more reward from them. They predicted future events, especially at a time when everybody was interested in what they might reveal: during war-expeditions. Before going to war, the chief sitting amidst his warriors, consulted one of the oldest and smartest conjurers (who had to be also an accompliished contortionist), concerning the result of the war, the force and the whereabouts of the enemy. In their midst the magician knelt down on his small round target in such a manner as not to come in contact with the soil; after various incantations he derived inspiration from demoniac powers, and while grimacing, drew a magic circle in the sand around his shield. After contorting himself in the most terrific manner for about twenty minutes, while singing incantations and uttering imprecations against the enemy, he finally stood up, and after getting cooler, he revealed to the "King" the number of the hostiles and their hiding places or whereabouts and the best moment to attack them.

Although we find no direct mention of *solar* and *lunar worship* in Pareja's writings, both prevailed among the Timucua, and solar worship throughout the Southern territories. The term acuhiba, *moon*, really means *indicator* (of time), literally: "the one who tells." The Timucua worshiped the sun under the image of a deer; they raised a stuffed deer-skin on a high pole and testified their reverence for it by singing and dancing rites.* The sun was invoked before a battle and praised after a victory gained; the natives once refused to accept meat from the French and

* This is perhaps the origin of the tribal name *Ais*a, *Ais*, *Ays*, previously mentioned.

made them understand that they were accustomed to wash their faces and not to eat before the sun had gone down.

Another object closely connected with their beliefs was the *sacred* number *three*. While the Maskoki tribes had a traditional reverence for the number *four* on account of the four points of the compass and the winds coming from each of these four quarters, and while they assigned a particular color to each of these four points, we find over a dozen references in De Laudonnière to a worship of the number *three* among the Timucua. They fasted three days at the death of a chief, their scalp-dances lasted three days and three nights; at the toya festivity, which probably represents the green-corn festivity of other Indians, men ran into the woods, as if crazed, and stayed there three days, while the women cut themselves and their daughters, crying "*he toya!*" Even in Pareja this number is alluded to, for he mentions that chiefs just coming into power ordered a new fire to be made in their cabins to burn during six days, and at sowing time the chiefs caused six old men (*ano miso*) to eat a pot of fritters. Six is the double of *three*. The holy fire in the temple of the sun, among the Naktche, was fed by *three* logs only; and a Peruvian creation myth pretends that *three* eggs fell from the skies; from the golden egg issued the royal family, from the silver egg the nobility, and from the copper egg the commoners.

Concerning their mode of *sustenance* the Timucua stood high above the northern savages, for they tilled the soil and were not altogether at the mercy of nature, when an inclement summer season had deprived them of food. A hoe, made of a heavy fish bone or shell adjusted to the end of a stick, served in loosening the compact soil; the women made grooves in the ground by hand and carefully deposited maize-seeds in each of them. Here the agricultural work did not devolve entirely on the women, for the males turned the soil with their hoes. They made artificial ponds to let fish, eels, turtles, etc., come in, and afterwards caught them when needed. They were drinking the black drink, an exhilarating beverage made from the cassine-plant (also known among the Creeks), and to this, probably, refers the charge of drunkenness made by Pareja. They ate alligators, snakes, dogs, and almost every kind of quadrupeds and fruits, and were seen mixing coals and sand in their food; their main staple, however, was maize, and the French saw them kissing the "baskets of mill," tapaga tapola, standing before them.

During the three or four months of the rainy season they retired to the woods and lived there in huts covered with palmetto leaves. They did so evidently to avoid the burning rays of the subtropical sun.

About their *arts and domestic life* not much is transmitted to us. The term taca ni timutema, "my fire is out" (Proc. of 1878, page 496), shows that they kept up the fire in the lodge all day. The description of the town, with the chief's house on a mound, as seen by Hernando de Soto on Tampa Bay, is too well known to need repetition here. The ordinary settlements of the Timucua were a conglomerate of huts surrounded by strong palisade fences, not unlike the *kraals* (from Span. corral, medieval

Latin: curtinale) of the Kaffirs. They must have been very fond of personal ornaments as Le Moyne's pictures tend to show, and tattooing with some indelible color was carried to a high pitch of artistic development. They seated themselves on coarse benches made of nine poles or canes running parallel, the benches forming half circles; there they held their councils of war and peace, while the women prepared food for them, or let the cassine drink make the round of the assembled warriors. They were adepts in the art of manufacturing fans, hats and other tissues from palmetto leaves, and also moulded large *earthen* vessels, in which water was carried. Not less were they acquainted with ideographic writing, for each of the two head-chiefs Olata Utina and Hostaqua sent five painted skins as presents to Captain René de Laudonnière.

A study of Pareja's *totemic list* goes to show that two kinds of descendencies existed among the Timucua. The names of the first refer simply to the relations which the men of the tribe or tribes entertained to their chief, as councillors, etc.; but the second list contains the ancient names of the gentes or clans, as given to them through their totem. The majority of these totems are names of animals, and herein the Timucua do not differ from other North American Indians east of the Rocky Mountains. The two lists of Pareja seem to stand in no reciprocal connection, and hence it is to be presumed that a man who belonged, *f. i.*, to the Anacotima could belong at the same time to the Apahola or some other clan mentioned in the second list.

Bibliography.

The following are the titles of Pareja's works consulted by me in the library of the Historical Society of New York:

I.

Cathecismo en lengua Castellana, y Timuquana. En el qual se contiene lo que se les puede enseñar a los adultos que an de ser baptizados. Compuesto por el P. F. Francisco Pareja, Religioso de la Orden del seraphico P. S. Francisco, guardian del Conuento de la purisima Cõcepcion de N. Señora de S. Augustin, y Padre de la Custodia de sancta Elena de la Florida. (Woodcut.) EN MEXICO, en la imprẽta de la Viuda de Pedro Balli. Por C. Adriano Cesar M. DC. XII.

In 16mo., eighty leaves or 160 pages, not numbered, but every quire marked with a letter of the alphabet running from A to K inclusive, at lower right hand margin, the leaves being marked with Roman figures: Biii, Biiii, Gii, Iv etc.

II.

In the copy consulted by me the following "Doctrina" is bound into same volume as part of a second Catechism:

Catechismo y breve exposicion de la doctrina Christiana muy util y necessaria, asi para los Españoles como para los Naturales, en Lengua Castellana y Timuquana, en modo de preguntas, y respuestas. Compuesto por el P. F. Francisco Pareja de la Orden de N. Seraphico P. S. Francisco, Padre de la Custodia de S. Elena de la Florida.

Follows a woodcut extending over more than half the page.

Back of title: Woodcut representing the infant Jesus with the cross, and Spanish verses to its praise. 176 leaves, paged only recto; the last three leaves 174–76 not numbered. Profusely illustrated with rough woodcuts. The colophon reads as follows:

Con Licencia de los superiores, en Mexico, en casa de la viuda de Pedro Balli. Año de 1612. Por C. A. Cesar.

III.

Confessionario En lengua Castellana y Timuquana. Con algunos consejos para animar al penitente. (*) ¶ Y assi mismo van declarados algunos effectos y prerrogatiuas deste sancto sacramento, etc. Ordenado por el Padre Fr. Francisco Pareja, Padre de la Custodia de Santa Elena de la Florida. Religioso de la Orden de nuestro Seraphico Padre San Francisco. Impresso con licencia en Mexico, en la Emprenta de la Viuda de Diego Lopez Daualos. Año de 1613.

Colophon: Aquino van puestos los Canones, hallarsean en el libro llamado segundo mandamiento.

LAUS DEO DEIPARÆQUE
o MARIÆ o

The book is in 16mo and the title is followed by seven unpaged leaves, containing testimonials and documents of the press authorities concerning Pareja's books. Follow eight unpaged leaves containing errata and list of contents. Follow leaves, the numbers of which run from 9 to 230, some set up in one, others in two columns, the former being more frequent. The volume is illustrated with many coarse woodcuts. The star, as marked in the title, occupies the middle of the page.

NOTE.—In the official preface to the Confessionario (leaf 3) the President and auditors of the royal "Audiencia" of New Spain mention the following writings composed by Father Pareja: "Fray Francisco Pareja de la Orden . . . . . a compuesto, traduzido y declarado la Doctrina Christiana, tres Cathecismos, Confessionario, Arte, y Vocabulario, y otro tratado de las penas del Purgatorio, y de las penas del infierno: y gozos de la Gloria, y el Rosario de la Virgen con otras cosas de deuocion, en lengua Castellana y Floridana, y gastado en esto mas de diez y seys años." It is possible that some of these writings have never appeared in print.

To the above I add the titles of two works by Gregorio de Mouilla, as copied from Icazbalceta's *Apuntes*:*

IV.

Explicacion de la Doctrina que compuso el cardenal Belarmino, por mandado del Señor Papa Clemente 8. ¶ Traducida en Lengua Floridana: por el Padre Fr. Gregorio de Mouilla Diffinidor de la Prouincia de santa Elena, de la Orden de S. Francisco, natural de la Villa de Carrion de los Condes

*Joaq. Garcia Icazbalceta, Apuntes para un catálogo de escritores en lenguas indígenas de América. Mexico, 1866, 12 mo, pag. 116-118.

hijo de la Prouincia de la Concepcion, y del Conuento recolecto de ñra Señora de Calahorra. Corregida, enmendada y añadida en esta segunda impression por el mesmo Autor. En Mexico Impressa con licencia en la Imprenta de Iuan Ruyz. Año de 1635.

(En 8°, 12 fojas preliminares. Fojas 1 à 197. 2 fojas de indice, sin numerar. Al fin :)

Acabose à 9. de Enero de 1636. con licencia en Mexico, por Iuan Ruyz.

V.

(A continuacion se halla este otro opúsculo):

Forma breve de administrar los Sacramentos à los Indios, y Españoles que viuen entre ellos. ¶ Aprobado por Autoridad Apostolica, y sacado del Manual Mexicano, que se vsa en toda la nueua España y Pirù, mutatis mutandis, esto es, lo que estaua en lẽgua Mexicana traducido en lengua Floridana. Para vso de los Religiosos de ñro Padre S. Francisco, que son los ministros de las Prouincias de la Florida. ¶ Por el Padre Fr. Gregorio de Mouilla. ¶ Con licencia del señor Don Lope Altamirano Comissario general de la santa Cruzada. Impresso en Mexico. Por Iuan Ruyz. Año de 1635.

(En 8°, 32 fojas. En la biblioteca del Señor D. J. F. Ramirez, México.) La primera edicion de este libro es de Madrid, 1631, en 8°; pero habiendo resultado con muchas erratas, volvió el autor á imprimirlo en México, corregido y aumentado. Así lo dice en su prólogo.

Radical Affinities of Language.

My attempt to compare the Timucua language with other linguistic families in regard to lexical affinity may be called premature, for we do not know over two hundred vocables of it with some degree of certitude. There are no two languages in the world which will not yield many real or fancied resemblances when confronted with each other, and to build air-castles on these has been a frequent mistake of many unexperienced investigators. Linguistic families, which are ancient neighbors of Timucua, are the Yuchi, Cherokee, Maskoki and Carib, but none of them seem to give any chances for fruitful radical comparisons, and Yuchi and Maskoki differ widely from it phonetically. The Carib or Galibi dialects, anciently spoken in the West Indies, are quite fluctuating in the pronunciation of their vowels as well as of their consonants, like some Polynesian dialects, and since we observe the same peculiarity in Timucua, an additional difficulty springs up in the way of arriving at a result.

A. *Timucua-Maskoki affinities.*

Holata *chief.* This Timucua term is evidently *loaned* from the Eastern Maskoki dialects, for in Creek holá'hta is a ceremonial title of men officiating in annual festivals and busks, and is often connected with the war-title hadjo, hádsu, which corresponds to our *bold, reckless* (holá'hta hádsu). In rank the holá'hta, hulá,χta stands below the tustĕnóki, who is himself inferior to the míko or chief. Holá'hta is

the word holáti, with prefix ok-: oχoláti *blue, sky blue*, the blue color having become in some way or other the emblem of these titled warriors. In the cognate Hitchiti dialect blue is holatle. Among the Creeks *blue* was the color symbol of the *south*.

Aba, abo stick, club; *stalk, plant;* maize-stalk; abopaha corn-crib; aboto to beat with a stick; abara maize field. In the Maskoki dialects this term appears as ápi in Creek: stalk, stem; adshim api stalk of maize or Indian corn; ádshi-intal-ápi cob of Indian corn. The Hitchiti dialect pronounces the a longer than Creek: āpi stem, handle; nofāpi beech, lit. beech-stalk. In Chá'hta this word may be traced in: nusápi oak-tree, and in haksh-ap bark.

B. *Timucua-Carib affinities.*

Piro *red;* ano pira *red man, Indian.* In Galibi ta-piré is red and yellow; in Tupi piranga is red; pira piranga red fish, name of some fish species (Martius); in Taino pu, bu meant scarlet.

Paha *house, lodge, wigwam.* In Arowak we find bahü (and: baacheh) house; boharque in Taino: bohio, buhü, ubanna: *tugurium*, in the same dialect (Martius).

Ele *young, fresh, recent.* In Eyeri el is *son*, in Taino el, ili, gua-ili (with demonstrat. prefix gua-, wa-) young, offspring, infant; in Arowak elunchy: boy.

Ichali *weir, fish-pond.* Raymond Breton (Dictionn. Caraïbe français, 1665) page 282, has ichali: garden for raising vegetables, p. 468: tona icali (or áriche), fish-weir: "réservoir de poisson," tona meaning river. The word oubacali he also translates by *garden;* oúbao island, icali garden. Ibid. p. 111: chaláali he was drowned; na chálaroyem I am drowning, I go to the bottom. These two words are evidently representing different linguistic roots, and the first has to be pronounced ishali, according to the French pronunciation. Pareja expressly states that ichali was used for *weir* on the coast, puye in the interior, and I think it may be a loan word from the south incorporated into the language after suppressing the tona, which alone qualifies the Carib word (as spoken on the island of Guadeloupe) as a fish-pond. In Eyeri, as spoken on Porto Rico, chali meant a garden also.

The terms pointed out certainly agree in both languages, but they may be loan words; even if they rested on a common origin, their number is too small to prove identity of ethnic origin of the two peoples.

Other resemblances may be traced, but they are too doubtful for being relied on:

hapu *three:* kabbuin, kabuin Arowak.

maca, moca *sea, ocean:* bagua in Taino; cf. pa in paraná, the Tupi term for *sea*.

iyorona *eel:* ihiri in Arowak. The Timucua word is derived from the verb yuru to shake, tremble.

Dialects of the Timucua Language.

This is a topic on which very few indications were transmitted to us by the authors. But we are told by Pareja that dialects spoken by one tribe were intelligible to tribes speaking other dialects. He mentions several dialectic differences, f. i., that between ichali and puyu *fish-weir*, yame and yamanchu *brother-in-law*, amitina and chirima *my younger sister*.

The dialects to which he refers, are :

1. The dialect of Timoga or Timagoa, on Lower St. John's River.
2. That of Potano, west of St. John's River.
3. That of Itafi.
4. That of the Fresh-water District.
5. The dialect of Tucururu, on the Atlantic coast.
6. The dialect of Santa Lucia de Acuera, a short distance south of Cape Cañaveral.
7. The dialect of Mocama, a term which means : "on the coast."

Many other dialects and sub-dialects must have been spoken throughout the vast interior of the peninsula, of which we have no knowledge. The most instructive passage on this subject is found in Hervas, Catalogo de las Lenguas conocidas, I, p. 388, who quotes Pareja, of whose writings he had seen none but the catechism of 1627 : "Los indios que tienen mas diferencia de vocables y mas toscos que son los de Tucururu y Santa Lucia de Acuera, por participar de la costa del Sur, que es otra lengua, entienden á los de Mocama, que es la lengua mas politica, y á los de Timuqua, como lo he experimentado, pues me han entendido predicandoles."

Thus Pareja declares the coast dialect of Mocama (which latitude?) to be the most polished of all and a medium of inter-communication with the southernmost dialect with its rude pronunciation. *Otra lengua* does not necessarily mean "a language of a different stock," but only *an idiom differing from ours*.

Grammatic Notes.

On account of the unsatisfactory state of the Timucua texts at hand, our grammatic and lexical knowledge of this idiom can increase but slowly. Pareja's "Arte" or grammar would considerably help our investigations, but no trace could as yet be discovered of its manuscript or of the book itself, if it has ever been printed.

The following remarks contain the result of my studies on the grammatic part of the idiom. Many of them may be revoked in doubt or corrected by further research, for the state of the texts often admits several interpretations of the wording. For this reason I have even hesitated for a while, whether it would be justifiable to publish them or not.

In *phonetics* the most prominent feature is the alternation of some vocalic sounds among themselves, and of the consonants pronounced with the same phonic organ of the vocal tube.

Other changes are very frequent also, especially those produced by contraction, viz.: synizesis, syncope, ekthlipsis.

Thus, the article (or pronoun) na frequently combines with the following word, whether this begins with a vowel or not:

na ucuta : nacuta, ucuta ; nacunu : na acu ano.

na uquostano : naquostano, uquostano.

iti-aye : itaye ; iti ayaqe : itayaqe; isaye isa : isayesa ; isaye nate : isayente.

soba hebi : sobaebi ; piaha : pia.

chuqua cosa : chuquosa ; chi iquila : chiquila.

aya-lacota : yalacota ; ano eyo : anoya.

The Verb.

The *verb* being the most important part of speech in every language, I first call attention to the polymorphic and intricate nature of its *inflection* as it appears in the texts. It certainly shows analytic features by not incorporating the subject-pronoun, for this may be placed before or after the finite verb, its place being determined by the run of the sentence. Where this pronoun is found combined with the verb, phonetic attraction alone seems to have produced this effect.

The synthetic character of the Timucua verb exceeds largely its analytic features or anything that could be construed into such. It shows itself in the formation of the modes, participles and verbals, of the numbers, of the voices and tenses, of negative and interrogative verbs. To express grammatic relation and derivation, prefixation is much less resorted to than suffixation.

A large number of American languages do not distinguish more than two tenses, though others show a variety of them. Timucua is poor in tenses ; the tense of the incompleted action, which mostly coincides with our *future*, is expressed by suffixing manda, manta to the stem, a derivative of the verb mani *to desire*. The fact that manda sometimes appears before its verb, and sometimes is used as a verb for itself (*to be willing, to want, to require*), proves that its real function is that of an auxiliary verb. As such it is placed after all the suffixes that may be added to the stem :

viroma niponosiheromanda bohobi cho? did you believe that the husband *would* possibly return (to you)?

honosoma cayamaquene ubahauetilamanda bohobi cho? did you believe that the deer and the partridge *would* not (no longer) be caught?

nocomilemanda it will become true.

The action completed or just being completed is expressed as follows :

1. When the action belongs to the *past*, and is expressed by our imperfect, preterit or pluperfect, -bi, -vi is suffixed to the stem or basis of the verb : taca quosobi cho? did you make a fire?

2. When the action is in course of completion, and the tense answers to our *present* tense, then the pure stem of the verb is used, and -la is added, when the action is done in the presence of the speaker : motala I assent, I agree (while I am here) ; habosotala I accept.

-la, -le being the particle of the *affirmative* mode, expressing certainty,

positive statement, actuality, can be added to any tense or mode, but is most frequently used to express the present, especially when the first persons are used.

nocomi ninihabe*la*manda bohobi cho? did you believe that he would certainly expire?

balu nanemima ohohaue*la* it gives everlasting life.

hanibiti*la* evidently he has not neglected.

In chuqualehaue chuquosa cho? how often did you do this? the preterit tense is not marked by any suffix or other syllable.

The *plural* of the verb is often indicated by the suffix -ma, in participles by the suffix -qe, both of which are used for many other purposes also. In the queries (Proc. 1878, p. 498) mante he desires, has pl. mantema they desire or want; lapustela it requests, pl. lapustamala they request.

No instance of a *dual* form has occurred to me in the verb or substantive. From yucha *two* is formed yuchaqua *both*.

Whether the verb is making a distinction concerning *male* and *female gender* is a matter of doubt, and I can adduce only one passage (ibid., p. 498), which seems to indicate some distinction of this kind:

viro uquata puenonicala I bring a male infant.
nia uquata puentanicala I bring a female infant.
viro niaquene puenonicala I bring male and female infants.

Of *the modes* of the finite verb one is marked by the suffix -hero, -ero, -ro, which expresses possibility and probability, corresponding somewhat to our auxiliary verb *may, might, could*. This form, which could be called either a conditional or a facultative mode, may be illustrated by the following syntactic instances:

anoco nihihero manibi cho? did you desire that anybody may die?
balu pontahero he may give life.
niponosihero-manda bohobi cho? did you believe that he would possibly return?

To show the forms of the *imperative* and *exhortative* mode with some degree of certainty we have not enough instances on hand.

Participles are formed by means of the suffixes -mate, -no and -ta, -te.

-mate corresponds to our participle in *-ing*, and to the Latin gerunds, but is appended to nouns also, especially when they become connected with verbal forms in -mate.

paha pononomate samota quosobi cho? after returning home, did you rub yourself with herb juice?

cuyumate honoso honomate feeding on fish and deer meat.

henomate ibinemate for eating and drinking.

etabualunimate after having given birth to.

-no, -nu is found in participles of the medial and the passive form:

eca*no* made, worked, worked over.

itori*no*lehaue equelacoma on days where (people) have to fast.

honoma, calama ituhu*nu*leqe fruits prayed over.

na care he*no*nano caqua all these things, when eaten.

-ta and -te occurs in participles of passive, and also of intransitive verbs; to distinguish it from the negative and the interrogative -ti, -te is not always an easy matter. -ta mostly occurs as the ending of a substantive.

ubuata caught, from ubua to catch, capture.

hibate missa tbe missa having been said, or having said the missa.

atofa hororoquene hebataqe when the owl and the red owl were screeching.

nimota being hunted.

ibirita (a woman) who is menstruating.

eta baluta (a woman) confined.

inosobote one compelled to work.

ituhute over which a prayer was said; prayed over.

There are two *negative* particles in the language, aya (ya) and -ti, -te. The former either stands for itself, or is prefixed to the verb; when prefixed it becomes only agglutinated to, not incorporated into the verb. Aya is a particle of an objective nature, while -ti, -te is used in a subjective, putative sense, the negation of a fact or thought existing rather in the speaker's mind, than objectively. Therefore it serves also as an interrogative particle, and then is mostly joined to in- as inti, though frequently found incorporated into the verb, and placed after particles of derivation. It then corresponds to Latin -ne in dicisne? and to μῶν (μὴ οὖν) or to our *not* in "don't you say?" which means the same as "do you say?" though with a slight shade of difference.

aya honoma ituhunu fruits not prayed over.

hanibitila he did not neglect.

manino-ticote without feeling hunger.

Diosi hubuasotanatila? have you not loved God?

isayente (for isaye nate)? is she thy mother?

isayeste? does thy mother say so?

The formation of reflective, reciprocal, medial and causative verbs is effected by derivational affixes, and some of them are mentioned among the "Prefixes and Suffixes of Derivation." How frequentative and usitative, durative and attributive verbs are formed cannot be determined yet on account of the infrequency of syntactic examples. Instances how derivatives are formed, will be seen under mo- and orobo- in the "Words and Sentences."

The Noun.

The Timucua *noun* presents many difficult problems. To designate the objective case of the direct object we find in the *substantive* four suffixes: -co, -nu, -ma, and the plural suffix -qe, or we find no suffix at all. While -ma is locative, plural and verbal suffix at the same time, -nu seems connected with certain classes of nouns only, of the animate as well as of the inanimate order. None of them is a sign of a distinct *case*.

chofama pilenoma ibine-ichicosa to throw liver and lungs into cold water.

ponachica viroma? niama? do you bring a male, female (infant)?

balunu nanemima ohohauela it gives eternal life.

The adjective, when used attributively, does but in a very few examples agree in its suffix with the substantive it qualifies, and generally has no suffix at all, but stands *after* the substantive.

-mate is a postposition joined to nouns, in honosomate cayamatequene, from the deer and from the partridge, Confess. p. 129.

The possessive pronouns can become suffixed to conjunctions and adverbs just as if they were substantives or participles. Thus the suffix of the second person of the singular, -aya, -aye is met with in examples like the following, which prove that these particles were originally participles or other nominal forms:

naquostanaye? in which manner you?

chucaya haheno? how often did you eat?

equelaya haheno chuqua? how many times a day did you eat?

The third person of the singular:

Diosi hebuano nemoquamima emoqua against God's law; lit. "God's law against his against."

In participles this is observed as follows:

orobotanaye one cured by you.

ara uque naponaye you anointed with bear's grease.

caqi nia hutanaye that woman with whom you slept.

ilifotanaye for your killing (deer).

A syntactic curiosity are the suffixed particles -leqe, -lehe, -ma, -mano, -qe, which are sometimes placed after each word of a series of consecutive terms. They serve, no doubt, to establish a connection or reference, or to show mutual coördination of these terms. cf. tacachuleheco, &c., Confess. p. 132 v.; cuyuleqe, ibid.

The suffix -qe often serves to connect a principal clause with the principal clause just preceding.

We also find repetitions of verbs and nouns, which seem quite unnecessary to us, and embarrassing the sense:

honoso henomate inti uquabi cho? deer-meat eating did you eat?

hehanimanda hanibi cho? did you quit to cease eating?

nia iquimi iquiti mosobi cho? did you insult any women? lit. "to women with insults did you insult-cause?"

Incorporation.

There are also a few instances where the nominal object, direct and indirect, seems to be incorporated into the verb, as it is the rule in the Aztec language. Traces of this have been discovered in many other American languages. Some of the examples below are simply compound words, which differ in nothing from the Greek *οἰκοδομέω* and the Latin *animadverto*.

utihanta one banished from home, exulant; lit. one yearning (hani) after (his) country (uti).

sobae to eat meat; lit. to meat-eat (soba-he).

ibine-ichicosa to put or throw into cold water; lit. to cold-water (something). It is not probable that cosa forms here a word for itself, but ibine ichi, a noun with its attribute, becomes verbified by the suffixation of -cosa. cf. afatacosi to gather chestnuts. If the relation existing between the suffixes -co and -ma was clearly established, we could decide whether -co is here the sign of the objective case or perhaps the radix of the verb coso *to make, produce.*

cuyuhanta one who eats no fish, lit. missing, deprived of fish.

atimoqua lord, master; lit. servants attend (on him).

As well as the direct and indirect object of the verb, other portions of the sentence can become incorporated into one single term in this idiom. If the constituent parts of the sentence, the subject, object, predicate, attribute, etc., were *morphologically* as well defined here as they are in the Indoeuropean and Semitic languages, this would be an impossibility. The grammatic affixes of Timucua do not bear the imprint of sharp logical distinction and segregation, but embody too many relations at once, material and purely relational ones, as we clearly perceive in the example of -ma and -mate.

Diosi hebuano nemoquamima emoqua, lit. God-law-against-his-against (did you proffer curses?). In this sentence -mima, which is the possessive pronoun *his*, could stand just as well after the possessor (Diosimima hebuano), but the simple fact that it can stand elsewhere also, shows us the true character of the language.

Soba sobaebi (for: soba-hebi) cho? did you eat meat? lit. "meat did you meat-eat?" Here the first soba is the object of the verb sobaebi cho, the second soba is the incorporated object of hebi cho only. This sentence seems *to us* to contain an unnecessary repetition, but the Timucua certainly did not consider it in this light.

Chuqualehaue chuquosa cho? how often did you do this? chuqua, how often, is here verbified in both instances, chuquosa standing for chuquacosa. This seems to be more than a mere ellipse of a syllable.

Cuyuma ubuata qibenco melasonolehabetele mosobi cho? did you order that the first fish (pl.) caught be not thrown into hot water? In the direct object, cuyuma ubuata qibenco, the last term only contains the sign of the objective case, *-co*, hence the two terms standing before qibenco must, in the mind of the Timucua, have formed one word only with qibenco through incorporation.

Ano pequataye inosobotequa: your subordinates who are put to work. Here the sign of the plural number, -qua, is appended to the last term only, though plurality extends to pequataye as well as to ano.

Paha pononomate, lit. "after-home-returning." After paha a postposition of a locative character is expected; its lack seems to prove that the Timucua regarded both terms as one compound word formed by incorporation of the indirect object into the verbal form.

Prefixes of Derivation.

Prefixes subservient to the formation of derivatives are not numerous and cannot be easily confounded with syllables entering into the composition of compound words. The demonstrative pronoun na, which we can often render by our definite article *the*, coalesces in some instances with the word following it after losing its accent, and the same is true of the pronoun chi *thou;* but these are not prefixes.

i-, verbal prefix: iquaso, iquase to screech, scream; iparu to swallow (?) iquileno in iquilnona married to the sister of my wife; iquiti to insult, abuse; ko, ccso and ike to make, do, to cause to.

i-, nominal prefix: ichini and chini nose, nostrils; iti father; isa mother; isale sister of mother. itori subsequent to; iquini breast, udder, milk; ibine water, lake.

yu-, yo-, a prefix equivalent to our *through, across* or *by, near, past;* yubueha, yubehe to transfix, pierce; yuquiso to deposit on the side of; yoqua past, bygone.

ni-, verbal prefix: mero hot, nimaru to preserve one's heat; naquila to perfume, ninaquilasi to perfume; pona to come, niponosi to return to; nacu to drink, ninacu to ask for a drink.

si-, verbal prefix of a medial signification, which frequently adds to the verbal base the idea of "for oneself" and is sometimes reflective. Siqi or siqisa in siqisama my father, lit. "the one who procreated me," cf. siqita pahana all people belonging to my house, family; uque oil, grease, suquoni to rub something on oneself (for si-uquoni).

Suffixes of Derivation.

A short examination of the specimens of Timucua given by me in the "Proceedings" will prove to readers that this language is in a high degree polysynthetic, not only in its signs or syllables of relation (inflectional forms), but also in derivational forms. Often one and the same syllable serves as an inflectional and as a derivational form, and it is a peculiarity of this language that these forms can occur in the form of whole syllables only, either single or double.

Suffixes are more numerous than prefixes. They are either inflectional or derivational. The latter alone will be considered in this chapter, and although the number of them as given here is rather small, Timucua forms a much larger number of them by combination. To define accurately the functions and origin of them all, is what a full grammar of this Floridian language will perhaps one day be able to give.

-ba, nominal suffix: hiyaraba lion; nariba and naribua old (of persons; from na ariba); hibe louse; soba meat, deer-meat.

-bale, identical with -male, Proc. 1878, p. 497.

-bo, verbal suffix forming transitive verbs: tinibo to pierce, perforate; iniso and inisobo to make somebody work; aboto and abotobo to beat with a stick; orobo and oroboni to cure, heal, to treat for sickness.

-cha, -chi suffixed to nouns is not a real suffix; it is the relative particle

cha, hacha, "the one who, those who, that which;" chulufi-chi those of the jay-clan or totem; caru yachimale she that was born with a brother, the female of twins, ya being the pronoun *she;* po-cha, and hachi-pa-cha somebody, anybody, lit. "the one who is born;" ela-pa-cha the members of of one family, lit. "those born young together."

-co in isitoco to cause to bleed; -co is a verbal suffix, but mostly occurs in combination with other suffixes and has a factitive or causative function: ichi cold: ibine-ichicosa to throw into cold water; afata chestnut: afatacosi to gather chestnuts; isi blood: isitoco to cause to bleed. -co also occurs in paracusi head-chief. This suffix seems to be merely the sign of the objective case, here incorporated into the verb.

-fa, nominal suffix: chofa liver, chorofa jay, atofa owl; ituhu to charm, bewitch: itufa conjurer. This suffix probably alternates with -ba, -fi, and also with -hi.

-hani expresses the idea of cessation, discontinuance, and is in fact a verb; when connected with other verbs it serves as a sort of auxiliary verb. (ni) he-hani-manda I shall cease to eat, I will not eat.

-la, -le, nominal suffix: itele uncle, so called by nephews: uncle on fathers' side; cumele heart; iqila sick, diseased; apahola buzzard, crow; eqe, equela day; tola laurel; anoquela lineage, kinship, pedigree.

-lesi, -lesiro, verbal suffix expressing the idea of *to become, to begin to be:* -si being causative, -ro pointing to probability and future time; -le seems to have the power of verbifying, like -si. Christianolesiro to become a Christian. holatalesiro to become chief. muenolesiro to receive a name; lit. "to begin to be called." abotosiro to receive blows, to get beaten.

-mi, verbal suffix: ene to see, enemi to discover, find out.

-mi, nominal suffix: nanemi perpetual; adv. always; nocomi true; hasomi those belonging to one lineage, clan-people.

-ni, nominal suffix: ichini nose, nostrils; ibi, ibine, ibino water, lake; he to eat, hini tobacco; the word for tobacco is in many Indian languages a derivate of *to eat,* because the smoke is often swallowed by the natives. meleni petticoat.

-ni, verbal suffix: hani to cease, stop: hanini to neglect. orobini to go to confession; orobo and oroboni to cure, treat in sickness; suquoni to rub oneself with. icasini to altercate, quarrel; pona to come: puenoni to bring.

-no, -nu nominal suffix, also found in participles of the passive: ituhu to pray, ituhunu prayer; hebua to speak, hebuano word, saying, discourse; pacano subsequent to; pileno lungs; ahono young; banino rainbow.

-no, verbal suffix: pona to come: ponono to return to; bohono to believe.

-ra, -ro, nominal suffix: aba maize, abara maize-field; itori late, posterior; hororo red owl; jufere fish-catcher's wicker basket.

-si, verbal suffix: afatacosi to gather chestnuts; elosi to whistle (or is it elofi?); icasini to altercate, quarrel; niponosi to return to somebody; ibinese to bathe; nulasi to tickle.

-so, verbal causative suffix: uqe rain: uquiso to produce rain; inoso and

inosobo to cause to work, to work somebody; ituhu to pray: ituhusu to cause to pray, to let pray; uquaso to give to eat; coso to make, produce; moso to make, cause; iquaso, iquase to scream, cry; inibiso to drink to excess. he to eat, heso to make eat.

-so, nominal suffix: he, heno to eat: honoso deer, antelope.

-ta nominal suffix, forming (1) nomina acti, and other terms: hibuata sayings, words, ceremonial terms; uquata body, flesh; afata chestnut; aquita maid; ibine water: hibita river; pequata bondsman; hulubota maize-ear. (2) occurring in participles: eta baluta a woman after confinement; ibirita a female during her period; nimota for na emota being hunted; ene to see: na eneta a seer, one who sees; heta nacuta adv. immoderately.

-ta, -to forms transitive verbs: abo stick, aboto to beat with a stick; isi blood, isito to cause to bleed; samota to tinge, rub oneself with; huta to cohabit with.

Conclusion.

A retrospective view upon all that could be gathered to this day concerning the structure of the Timucua or Atimoke idiom shows it to be remarkably simple as far as its *phonetic* structure is concerned, but intricate in its morphology. Its syllables consist either of one (long or short) vowel, or of one consonant followed by one vowel. When exceptionally two consonants are joined, some vowel must have been eliminated. The r seems to be a real trilling sound, and not a graphic substitute for some other sound, for it alternates with no other sound but with l.

This elementary syllabism impresses its character on all the *morphologic* features of the idiom; roots, prefixes, suffixes are monosyllabic, or if polysyllabic, the suffixes at least can be proved to be compounds. A vocalic character is imparted to the language by this elementary syllabism, but whether the idiom was *sonorous* is still an open question, the solution of which depends on the fact, whether the vowels were pronounced clear or dumb. No doubt the Timucua dialects showed some differences in this particular among themselves.

The language is thoroughly synthetic in forming the voices of the verb, possesses an affirmative form in -la and a negative form in -ti, and verbals as well as participles are formed by suffixation. Its synthetic structure is also shown by its numerous array of derivational prefixes and suffixes (in this respect Timucua is polysynthetic, not synthetic only), and by a set of postpositions and case-postpositions affixed to the noun. A possessive case does not exist; possession is indicated by a possessive pronoun added to the sign or term of the proprietor, or by placing the latter before the thing possessed. The other nominal cases are not made clearly distinct from each other by their postpositions. The synthetic character of the idiom is shown also by various suffixes, which serve to form a plural in the noun and in the verb, and by others which impart to the verb a modal or a temporal character.

Timucua is analytic in not incorporating the subject pronouns into the

verb; they are placed either before or after the verb. Concerning the object pronouns the evidence on hand is too scanty. The nominal object can become incorporated into the verb, but this is not done regularly.

The language has two relative or demonstrative-relative pronouns, hacha (cha) and acu, which help in a great measure to disengage the intricacy of construction and prevent the language from becoming too "participial." The number of conjunctions seems to be rather small, and in this respect the language is far from being analytic.

The most important question of morphology to be decided by every linguist who gives a grammatic sketch of an idiom to the world, is whether the idiom possesses a *real* verb or not, the verb being typical of the language itself. For the Timucua the answer is, that the verb is neither a real verb, nor a pure noun, but a noun-verb. It is true that the plural is formed in the same manner and by the same suffixes in the noun and in the verb, as we find it done also in the Maya family; it is true that no real subject-case exists, and therefore no real case for the direct object either, all the nominal postpositions being originally of a *locative* character, as it seems; it is true also that several relational suffixes of nouns repeat themselves in the verb. But the subject-pronouns are by no means identical with the possessive pronouns of the nouns and participles, some of which are always suffixed, not prefixed to them, and though the verb does not inflect for person, it inflects for tense and mode. The verbal forms which correspond to our finite verb are *nomina agentis*.

The result is that the verb of this peninsular idiom is a mixed production between a real verb and a noun used as verb; it is a *noun-verb*, holding a middle position between the finite Indoeuropean verb, and the finite Algonkin and Creek verb, both of which are *nomina actionis*.

The nature of the texts makes it difficult to find out whether there is a substantive verb *to be* or not, and therefore we are still in the dark concerning the attributive verbs. However, the existence of a verb *to be* is very improbable; it is often circumscribed by the article *na*. Adjectives used attributively are sometimes inflected with the same postpositions as the noun which they qualify; sometimes with other postpositions, while at other times they show no inflectional endings at all, which proves that they were then considered as forming *one* term with the noun, which they qualify. They always *follow* the noun, unless used predicatively.

The incorporative tendency of the language has been spoken of above. It is not very prominently nor frequently put to use, and most sentences do not show any trace of it; but it *exists*, and this fact is enough for us to direct our judgment concerning the nature of this southern idiom. Subject pronouns and some of the adverbs are not, but most other parts of speech can become united with the verb, or among themselves, into "collective terms," which are so instructive for the study of agglutinative languages.

SELECTED TEXTS.

Questions Addressed to the Chiefs.

Holatama bueta yechinoma cantela.

(Pareja's Confessionario, leaf 183 v.—184 v.)

Did you exact more tribute or other articles from your subjects than you were formerly in the habit of doing?

Andaque cumeleta hachibueno hachi ichusubinaco christianolenaye ofuenona yameta hachima osoarosota nichusimaca mobi cho?

Did you exact the labor or day's work from those who work for you?

Ano pequataye inosobotequa hacheleheco yerebana nayolehecoquene hochi uquabi cho?

Did you employ your subjects at some work, so that they missed the holy mass?

Ano pequataye inosobo chique Missaleno hani mobi?

Did you order [them] to work on feast days without the priests' permit?

Itimilenoye inosohale masetiqua fetecatiqua fiesta equelama inosobi cho?

Did you order, that no one open the corn-crib or approach it, unless the conjurer has previously said his prayers over it?

Ano misoma ituhutetima avohopahama iqinoleheleqete mobi cho?

Did you forbid to eat of the new maize or other new fruit, before the conjurer has tasted it?

Tapolabacaqe aya hono tocaco tocoqe uquaca ano misoma hetetileta heqeqere henolehabela motabi cho?

Did you design that weddings should take place to the benefit of the Indians without giving a share to the priest?

Anopira comeleta niamate nata hibuasi mota viroma nacunata hibuasomata mosobi cho?

Did you consent to [your] slaves' sleeping together?

Ateco anoco fastaqe nate manibi cho?

Do you keep any negro slave as a mistress?

Atemimaqua inihimi chu mosobi cho?

Did you consent that some people of your village recite incantations over some herbs?

Hicaye ano niye uquata ituhuteco hibuataqe nate naquenta hanimate manibi cho?

Did you cause any conjurer to search by diabolic arts for something stolen or lost?

Nuquenoco hachibueno teraco chebeque yalacosobi cho?

After eating bears' meat did you ask for drinking from another shell, lest you would fall sick?

Ara-hete toomama nacunuma ninacusi chi caqe honi-hete ninacuqe niqilabosohabele nacunu eyo nacunulehaue mosobi cho?

To preclude young women from dancing did you have some of them insulted, or inflicted punishment on them?

Ela nia muquano iquimi iquiti mosobota hachibueno nabalusobota mosobi cho?

Early in the sowing season did you cause six old men to eat [a pot of fritters]?

Echerosota ano miso marecama hesobi cho?

Just before becoming chief did you order a new fire to be made for six days in the cottage, and to have it closed up by laurels or other things?

Holata ichi qihabeleta taca chaleca alata itorita ela marcca hutanolehaue, acu tolalehecote hachibuenolehecote viro pahama naquiluta mosonolehaue mobi cho?

Did you desire the chief's death to succeed him?

Nihitaruqe honihe holatalesiro manibi cho?

Having fallen sick, did you construct a new house, declaring "Here I shall live and die?"

Chiquilabotanimano paha chaleca ucunuleqe fata orobinihale caqua fanomano ninihihauele mobi cho?

Did you order laborers to be punished so as to have their arms broken, not for the sake of work, but for being angry?

Anoco inonino namoquatima maha ine eyo nayuricomita chacali carema tuchemaca mo chi abotomoque yabi vichubi?

For what other reason, but for being angry, did you have anybody punished?

Anoco ineca luba ticote hochie yuricono yebueta iqimileqe ineco nahiqe abotosiro-manda quosta nasisobi cho?

Indian Prognostications and Pagan Ceremonies Still in Practice.

Anopira hachicare isinomite hitinacumelenomatequene cantela.

(Confessionario, leaf 123 r. and v., 124 r. and v.)

When somebody was crazed, did you believe [his] words would become true?

Isucu echa, hebuatema nocomilemanda bohobi cho?

Did you believe that it was a sign of somebody's arrival, or that something new would happen, when a jay was chattering to another bird, and when my body was trembling?

Hachipileco cacaleheco chulufi eyolehecote nahebuasota, caquenihaue qestela, mota unayaruru catemate, caquenihaueqe intela manta bohobi cho?

Did you believe, that by making a new fire in a separate spot, the sick would recover?

Ano iqilabamabuetaleqe taca chaleca arecotana baluhauele-manta bohobi cho?

When you were sick, did you have a fire (candela) made separately so that they may cook victuals to be your food, for otherwise you would die; did you believe in this?

Chiqilabotaqe, taca chaleca nalasinolehaue hono intico tacama echeqe ninihihauela-manda mosobi cho? yanacu ano eyocobueta motaqe bohobi cho?

When a woman was in travail, did you think it sinful to approach the fire (lumbre) just burning?

Vilu tacaco inti uquata ibiretacoco inti uquata quosobi cho?

Did you consent that a herb-doctor should cure you by reciting over you demoniac words?

Isucuma chorobonima hiti hebuata ituhuta choroboqe nate manibi cho?

Did you offer to this purpose at the door of the house the maize to the Devil, as you were in the habit of doing before?

Tapolama ucuchua easota hitima tacatosibinaqechu naquosobi cho?

The ceremony of the laurel, performed to [serve] the Demon, did you perform it?

Tola ucuchua nacaquibinaqechu naquosobi cho?

[When collecting] acorns or other fruits, did you not eat the first [gathered]?

Ahano calama qibemate, hachibueno eyo calama qibemate inti uquabicho?

When lightnings struck into the clearing (roça) or maize-field, did you not eat of it? and did you advise anybody not to eat of it?

Pilema numa hebuama nabotoqe, tapolamano inti uquabicho? yanacu ano eyo, inti uquasota, mosobi cho?

Did you advise not to eat the first maize of the newly-cleared field?

Auara ele tapolama ecano qibemano inti uquata mosobi cho?

When the water is flooding the new fish-pond and the first fish is caught, did you order not to throw it into hot water, lest no others would be caught?

Ichali ele iribosobinaco, cuyuma ubuata qibenco melasonolehabetile cuyuma naqua ubuahauetile naquosatiqua nimaca mobi cho?

Did you place the first fish close to it (the new fishpond), to make come a large quantity by the next tide?

Cuyu ubuata qibenco yuquisotaniqua, cuyu arota ubuahauele-manta quosobi cho?

When flooding a new fish-pond, did you desire that the conjurers pray over it, believing that many more fish will enter it?

Ichali ele iribosota, hiti hebuanomani ituhusinoleqe ubahauele manibi cho? yanacu ituhubi cho?

(Same sentence, the inland term *puye* "weir" being substituted for ichali, used on the coast.)

Puyeca quibinaco hiti-hebuanomani ituhusinoleqe hubuahauele manibi cho? yanacu hoqua ituhubi cho?

(Confessionario, leaf 127 v.)

All these things, all these abuses, the tremblings of the body, the omens from the birds, from the beasts, nothing of them must be believed in.

Una caremaqua hachibueno, care nayalacota, caque nihaue yatala muenomate isticoqe namota bohonole bitima chisisotamano bohatiquani hach(e?).

To Married People.

(Confessionario, leaf 208 r.)

Did you suspect your consort of some wicked action?

Inihimima inibati cumelesta inta ninco nahe v- nale manibi cho?

Did you outrage your consort by affronting terms, by insults, by scoffing, or by laying hands on?

Inihimima hebuanoleheco ininoleheco mosima na-isticosota iquitimosota hebuabi cho?

Have you gratified too much the desires of your sons, allowing them their own will without punishment and correction, and leaving them their liberty?

Siquisonaye maha ere timoqiti mine cumelebi nincoqua na-intanasiqi puenta honochiqe heta nacuta orobistileno chiqena inta alihotahabe nate manibi cho?

Did you consent that your son or others of your house act in a turbulent or knavish manner?

Siquisonayeleheco anoyaleheco orobistitima anoletaqe nate manibi cho?

Did you give no longer to eat to your husband, and did you not act upon his command?

Inifaye cobuosatileta hono, nacume ecatileta tera hebuatanima hanisobi cho?

(Here follows: Have you not murdered.....Proc. 1878, pg. 499.)

Misdeeds to be confessed to the Priest only.

(Catechism, leaf 83 verso to 84 verso. In the original, this article is *not* divided into paragraphs or sections as here.)

Hono-melomano pilanileqe nabe chaleqe quenema hayarota ebetoqe ibama nahabosoqe mosotequarebama nahitanima; naquentequa elasosiqe nimarubi michuqui mosilenomano anoco, neneha manibi michuqui mosimano hecate.

The shell of the ocean opens every night and every morning to receive the dew from the sky, wherewith the pearl congeals in it; the pearl locks itself in, when the sun has risen and the day has advanced, and preserves its natural heat (y viene escalentando), and so that it may be seen afterwards by all, it locks itself in.

Naqui monihauemano iniheti ininomile atichicolo orobotemaqua orobinta naahosta mosonihauele caqi ano orobotemano Iesu Christoma, na ichiqitechule.

We likewise must manifest our shortcomings only to the confessing priest, as to a vicarious person for Jesus Christ, and to none else.

Naque nihaue quentelaha yahamosimano isticoma inta nabo nabomota, naquosonole hetimane na anolatema.

Many are doing just the opposite of this; those who glory themselves when acting mischievously and praise themselves on account of their sins.

Nahitela naquenema Esaias: Istanimano namotemano mine istico inino mimaqua na-iribota hebuata nelacare chienta, Sodoma hicayayima, anoma isomoni michuqui mosotema nahitela.

Naquenema hanta eyobeta taanolenomano unabine yuchinoma elacare chieta, halifonoma nantela.

Gatomano piaha-manda ayahibuanoma; piteta nuqua ecate hachipile inemimano, yuchi nihe mosima, apimimaqua nacuquete una oqùo yuchi namotemabeta, na-iqilabono nahitemano isucumaqua nahiabosota eyomano.

Chiqesta mosote quentemano iniheti ininomileno eyomano; chiqesta atichicolo isucumaqua sacerdote intema toloba ajosta na-orobininolehauela.

Naquenemano ano yaha mosimano iniheti ininomima yucheti elacare ahota.

Acu caquenta nabalu hache itimilonoma mota nimate canimasela mota nabeta nabonta na-anoletema na hitela quosonolebitila Sacramento na-orobininoma nabena sabata isonola naquenema intila.

Of these people says the prophet Esaia: "Peccatum suum sicut Sodoma praedicaverunt." They have praised and publicly exhibited their sins, like those of Sodom.

That the sinner should reveal his sins, unless while confessing, seems to be against nature.

Cats will hide their excrements and cover them well [so that they do not stink nor smell bad to others], and all animals cover themselves by their tail; and people who have any ugly infirmities conceal and hide them from others' sight, except from the physicians who are to heal them.

All this teaches us, that sins must be covered and concealed from all, save from the spiritual doctors, to whom they must be confessed openly.

Sinners must not be like monkeys, who show themselves nude to all, without shame or bashfulness.

There are people, also, who divulge not only the sins which they have confessed, but even the penances, which they have endured for them, and in this manner almost expose to mockery the Sacrament of the confession.

Miscellaneous Queries.

(Confessionario, leaf 210.)

Pahamico anomileheco ano eyolehecote quenema inibati intaqe nate manibi cho?

Did you permit any married or other person to have sexual intercourse in your house or elsewhere?

Inihiminco ano eyo napatabohero maninoma nate quentahaue manibi cho?

Did you consent that any one have connection with your consort?

Niaco obachamisibi cho?

Did you kiss a woman?

Chuqua?

How often?

Niareqe chuquareqe?

How often each woman?

Caqi nia hutanaye inemimano anomicote hu'abi cho?

Are there any mothers among all those with whom you had intercourse?

(Catechism, leaf 50.)

Santa Maria aquitasiqema hebuasta istala. — I speak with the Virgin Mary.

Caqi aquitasiqe Mariancono chicaconte? — Who is the Virgin Mary?

Mine (h)achibueno tera inemi naya iynomate, graciamate nacumotaqe iyenotima; nocomi Dios-isomima nantela. — Some great queen, rich in all virtues and graces; the true mother of God she is called.

Caqi minequa iyenotincono chanco hibuante? — Where dwells this grand queen?

Hachaqueniqe Diosima muenolete? — Why is he called God?

Nanacu hachibueno carema naeneta naqebanta, numamate utimate quenequa mine ecoyaleta hachibuena carema caquenta hauemantema nantaqe ona Diosila. — Because he sees all things, and ministers to them, he being the powerful ruler of all things in heaven and on earth.

Dios itimi, Dios qiemima Jesu Christo nante, Espiritu Santomate. — God father, God's son Jesus Christ, and the Holy Spirit.

Ano qiemamate Diosi? — Is the Father God?

O, Diosila. — Yea, he is God.

Quiemilenomate Diosi? — Is the son God?

(Catechism, page 27v.)

Mime una oquomimano hachaquenta tuqualamanafaye? — In which state did his body remain when in the tomb?

Nanacu una oquomano utinaleno divinidad muenomacasinta yahota fayela. — His body was united with the Godhead itself.

Nihinima hachaquentaquere tabuale? — In which manner did he rise from the dead?

Acuyano, hachequeniqe Christianolehala mote cho? — Furthermore, why do you declare that you want to become a Christian?

Mine Diosi maqua, inostaniqua numa abo orabonoma nimihero nimandaqe, Christianolesiro ni manela. — That I may serve Almighty God, go to Heaven, and that there the glory may be conferred upon me; therefore I want to be a Christian.

Address of Thanks,

Sent to the King of Spain by his Loyal Subjects, the Chiefs of the Timucua People; dated the 28th of January, 1688.

Shortly after the revolt of the Indians of the northern part of the Floridian peninsula against their Spanish governor, who attempted to send some of their number to the mines in the West Indies, and after the inroad of the Yamassi Indians into their pueblos (1687), the loyal Apalache chiefs sent a letter of explanation to the Spanish monarch, dated Apalache, Febr. 15, 1688, and endorsed by the Governor Diego de Quiroga y Lossada, "Capitan-general," on April 1, 1688; the Timucua chiefs sent to him a loyalty address bearing date of Jan. 28, 1688. The vidimus of this letter states, that it was "escrita de todos los CaCiques de la timucua," and translated by Fray Francisco de Rojas, a Franciscan of Santa Elena Province, interpreter of Timuquano in the city of St. Augustine and "ministro de los naturales, etc." This remark of the translator is dated February 17; the vidimus of the magistrate, "Alonsso Solana," is dated February 21, 1688.

The Apalache and the Timucua letter were published in fac similes of the original documents, with printed Spanish translations and vidimus, by Mr. Buckingham Smith, in an undated (1859) folio edition of nine leaves, and printed in fifty copies only.

A copy having no printed title is in the Library of Congress, and from this I have reproduced the text below. Leclerc mentions the publication of Mr. Smith in his "Bibliotheca Americana," Paris, Maisonneuve & Co., 1878. 8°.

In my English rendering of the address I have followed as closely as possible the corrected Timucua text. The vertical bar | shows the end of each line in the text of the original.

Readers will remember that only the "*Text of the Original*" and the "*Spanish Translation of* 1688," are reproductions of what is left to us. The original is worded in a dialect differing in some respects from that found in Pareja's books, and was written some eighty years later. Where we find, *e. g.*, lahacu, bota in the address, Pareja would use leheco, mota. The queer orthography of the original prompted me *to attempt* a more correct reading of it, and this I have sought to reproduce in my English translation.

At the head of the letter stands the sign of the holy cross, and in the original it is repeated where the C stands before reiheca. Every C of the text is written as a capital letter. The i's have all long oblique dashes over them (ſ). In the term namonimanibotela the *nam* is erased in the original with ink. Numerous difficulties still encumber the full understanding of this interesting missive.

Spanish Translation of 1688.

†

Al Rey nro Señor

Siempre emos sido vasallos de V. M. pero agora con mejor raçon y de ttodo coraçon lo somos y asi queremos hablar.= V. M. a ynviado muchos governadores pero como Don Diego no emos vistto ninguno; otros que an sidos governadores estan aqui pero como este no emos vistto ninguno, y por estta causa damos a V. M las gracias; nos a socorrido a los casiques y pobres vassallos de V. M. con ropa por cuia causa estamos muy agradecidos. Dios se lo pague a V. M.; y si los señores governadores que han benido fueran como el que oy esta fueramos mejores xptianos y hubiera muchos mas xptianos. Su me^d a trauajado mucho en ntro vien con tan malos tiempos y por si mesmo a uisitado ttodos los lugares de xptianos y de ynfieles como fue Basisa y nos a dado mucho consuelo y con todos estos trauajos nunca a dejado de oy^r misa y así deçimos q^e es un hombre santto. A nos encargado mucho que honrremos que rreberenciemos a los saçerdottes que nos asisten, como su m^d lo açia delante de nosotros, suplicamos a V. M. se sirua de continuarnos muchos a^os al S^r Governador que es porque procura n^ro vien aconsejandonos como buen xptiano que oygamos misa y atendamos mucho a lo que los rreligiosos nos enseñan; boluemos a suplicar a V. M. nos continue el S^r Don Diego nuestro Gobernador para nro consuelo: nro Señor de en ttodo a V. M. ttodo goço y salud como estos pobres vasallos le desean: escrita en S^a Matheo en el mes de henero veintte y ocho de mill ss^os y ochentta y ocho años. Escripta y firmada de los casiques que nos hallamos presentes.= Don Franco casique de San Matheo. = Don Pedro casique de San Pedro.=Don Bentura casique de Asile.=Don Diego Casique de Machaua.=Gregorio casique de San Juan de Guacara. = Franco Martinez Residente en San Matheo.

Text of the Original.

†

C reiheca AnoConiCa

nanemí Anequelamítonoma ní eíabobíla hacacheqeno | Cumenatimoco Co Anoquelamítonoma ní eíabotela | queníqe Anohebasísíronimanibotaqe— — — | Anonaío holata puquahímesoboníbílahaCu | dontieCunaquimosí níenebobítíla Ano naío holata | yoqua Caremate eíatamalahacu naquímosí ni | enebobitila naquenema betaleq diosíquimí leqeysa- | co niquosoboríhabenamotaniCa icholataynemímote | Anoquelacunemate Amunapuquanínabarasobo | ta níquo soboníqueysacomanta < intanicala Acu Ano | naioholata ponobí íequcaremaCa. Co niso bonemaqu | mo sínisobomobileníncono Cristiano nípuquaCoColebo | hela Cristianoleno lenolehabema tacubaníheba | síbonela mínete pataquílononebeleca ynta Crístí. | Anoutíma níparífosibonelahacu pataquilonoma | quayquímíleqemisamano haninibiti la santole | nelenela *nam*onimanibotela ytecarena boso | noletahabe caremate nihebasibotamosoniqeysa | Comanta eíatanicaRemisa oCotono letahabeCa | remate níhebaneCa sibotahomotaminiqe ysaco | manta eíataniCare naquenemabetaleqe Caqi | Anonaíoholatahibantema diosiquimileqe | Anilapusimitanicale diosibalunu ohontahaue | tomanCo Caquanihi basibontaheronímaní | botaqe Anihebasímitanibale San Mateo | enero elaotuma yuihoqe piqinahíi eromano 88 | don fransisco naystale Acu franciscamartine | Don P San P^o holata Dudie go MacbaUa holata | Venturo Asile holata Gregorio S Ju^an ho | lata — —

Text as corrected by myself:

†

Reyheca anoconica :

Nanemí anoquelamitonoma ni eya bobilahaca cheqeno cumena atimococo anoquelamitonoma ni eya botela queníqe ano hebasi siro nimani botaqe.

Ano nayo holata puquahi míso bonibilahacu Don Diecu naqui mosi ni-enebobitila; ano nayo holata yoqua caremate eyatamalahacu naqui mosi ni-enebobitila. Naquenema betaleqe Diosi iquimileqe ; isaco niquoso ponihaucna mota nica naye holata inemi mote anoquelacunemate amuna puquanina barasobota niquoso boniqe isaco manta intanicala. Acu ano nayo holata ponobi yoque caremacaco nisobonemaque mosi nisobo mobilenincono Cristiano nipuqua cocolebobela Cristianoleno lenolehauema. Tacubani hebasi ponela mínete pataquilono nebeleca inta Cristi (-anole?) ano utima niparifosi ponelahacu pataquilonomaque iquimileqe misamano haninibitila santole nelenela nimani botela ; itecare nabosonoletahaue caremate nihebasibota mosoniqe isaco manta eyatanicare misa ocotono-letahaue caremate nihebanica sibota homotaminiqe isaco manta eya tanicare. Naquenema betaleqe caqi ano nayo holata hibantema Diosi iquimileqe, ani lapusi mitanicale Diosi balunu ohontahaue tomanco caqua nihibasi pontahero nimani botaqe. Ani hebasi mitanimale San Mateo, enero erao tuma yuchaqe piqinahu eromano 88. Don Francisco na-istale, acu Francisco Martinez. Don Pedro, San Pedro holata. Du(n) diego Machaua holata. Ventura Asile holata. Gregorio San Juan holata.

English Translation :

†

To our King our Lord :

Always we have been your subjects, but now with more reason and with whole heart are we your subjects, and intend to speak in this way.

Some white governors you have sent us, but like Don Diego we have seen none ; former white governors stay here, but like him we have not seen any. Therefore we invoke (upon you) the grace of God ; he has succored us, the chiefs and the poor subjects (of you) with clothing, and for this cause we show our gratitude. Those white governors who came (here), had they all been like the present one, we would be better Christians, and there would be many more Christians in existence. For our benefit he has worked a great deal, and in person has visited all settlements of Christians and unbelievers, has helped us with advice, and having during all his trouble never neglected to attend holy mass, we hence call him a saint; all the priests who assist us, he told us to honor and reverence, as he has done himself before our eyes. We therefore pray you to let the governor stay many years with us, for he works for our weal, advising us to hear mass, and listen to the teachings of the priests. Therefore we supplicate, that God bestow His graces upon this white Governor, our adviser ; we all pray God he may give life (to him), and thus we constantly pray and wish.

We all present have thus spoken at San Mateo, the twentieth and eighth day of the year (16) 88. Don Francisco was speaker, and he Francisco Martinez. Don Pedro, chief of San Pedro. Don Diego, chief of Machaua. Ventura, chief of Asile. Gregorio, chief of San Juan.

PROC. AMER. PHILOS. SOC. XVIII. 105. 3L. PRINTED MARCH 29, 1880.

WORDS AND SENTENCES.

acuyano besides, further, furthermore; in addition to.

afuenoma, see ofuenoma.

Alimacani a Floridian chief, also called Halmacanir, Allimicani paracussi; contains the word maca, moca *sea, ocean*. The map in De Bry, Brevis narratio, locates his settlement on the coast, just North of the mouth of St. John's River.

anoleta knavishness, sin, misdeed.

antipola bonassu. These words were uttered by the Indians on the St. John's River, when they saw De Laudonnière revisiting them on his second expedition. They seem to represent the Timucua words: "anta, balu pona cho?" brother, have you come (returned) alive? This author interprets them by "brother" or "friend," and A. Gallatin (Archæol. Amer. II, page 106) attempted to explain the first word by a Chá'hta, the second by a Creek term.

ati, ate subordinate person; slave, subject, servant. Atemima chu somebody's negro slave. Atemalema master and slave, or: female slave and owner.

atichicolo spiritual.

atichicoloye atimoqua your spiritual lord; your Christian God.

atimoqua, atimoqe master, ruler, lord; from ati and maqua, moqua.

Atore, Athore, nom. pr. of the eldest son of the paracusi Saturiwa (De Laud.). Contains the word itori following, subsequent to.

ayahibuano excrements; lit. "what cannot be spoken of."

benasaba, balusobo to dance.

betale to supplicate.

Bimini, nom. pr. of the mythic "Fountain of Life" imparting eternal youth to those who drank from it and restoring health to the diseased. Ancient traditions and maps place it on an island north of the Bahama Islands. Contracted from ibine mine, "superior water." The authors of the sixteenth century mention the Antillian bi *life* and mini *source*, but I have looked in vain for analogies to these terms in the other Galibi dialects.

cani 1) palmetto leaf 2) hat made of palmetto leaves.

care, pl. carema "together;" expresses the idea of temporal and sometimes local simultaneity. Viro niaquene care uquata: male and female infants at the same time. Caru amitimale: male twin, lit.: brother born at a time with a sister. Hica no*coro*male: fellow-citizens.

Chilili, nom. pr. of an inland Indian town, on an affluent of St. John's River, and of its chief.

Chiquola, nom. pr. of a "great lord of the country," dwelling north of St. John's River. His stature exceeded that of his subjects by more than one foot (De Laud.).

chulufi, chorofa jay; chulufi-chi those of the jay-clan (chi, apher. of hachi).

cote, ticote, ticotacu, cotacu (suffixed to verbs): unless, lest, if not; although, though not.
manino ticote without feeling hunger.
cote, cota tongue; language; portion of discourse, paragraph.
mine cotemano the first part (of book, sermon, etc.).
anacoti councillor, adviser.
Cuaresma the fasting period of Lent, lat. quadragesima.
Cuaresma pira: Red Lent, viz: Lent marked red in the calendar.
cumele heart.
cumelenima bohote cho? do you believe with (or *in*) the heart?
cumeleno natimo heartily, with full heart (de todo coraçon).
cumelesota document; c. hebuanoma d. of all what was said.
ecaleta to perform, to obey, act upon something.
ecano made, prepared; part. of ica to make.
auara ele ecano field recently cleared or prepared for maize-culture.
ecoyaleta ruler, manager.
elo, elosi, or elofi to whistle, hiss at; aqetu elosibi cho? did you hiss at the tempest?
Emoloa, Emola, Molua, nom. pr. of a Timucua settlement and of its cacique or chief, who is reported to have been subordinate to the Holata Utina. De Bry's map has a locality Homoloua on the St. John's River, near Fort St. Charles.
equelete to-day.
hachipacha some person, somebody; lit. "who is born."
hani to cease, stop, quit. itorinoma hanibi cho? did you cease fasting? Missaleno hani to miss the holy mass. inifaye viroma chi haniqe after your husband had left you.
hanini to neglect; haninibitila he has not neglected.
utihanta exulant, deserter.
Helicopile, nom. pr. of a chief (De Laud.).
heso to cause or give to eat; from he to eat.
heta nacuta, heta ucuta to excess, immoderately.
hete what can be eaten: meat, food, edibles; hetetileta untasted yet.
ara-hete bear's meat; honi-hete edible mussel, nutritious sea-shell.
hiatiqe interpreter.
hibuasi, hibuaso wedding.
hini tobacco; der. of he to eat.
Hiocaia, nom pr. of a chief dwelling twelve leagues north of Fort St. Charles. From hio to imitate, and caya turkey, partridge, the name perhaps referring to a headdress of feathers.
Hirrihiqua, nom. pr. of the Timucua chief, who captured Ortiz, a Spanish soldier. This is in fact a local name; War-land, or war-district (iri, hica).
hitiqiri owl, lit. "demon-screecher."
hochie, hochi, echa, other pronunciations of hacha, pron. relat.
hono 1) shell, fresh-water or sea-mussel; lit. food (he: to eat).

honi-hete edible shell, bivalve; hono-melo shell of the salt (melo) water; oceanic shell, pearl-shell. On Floridian fresh-water shells, shell heaps and shell mounds, cf. Fifth Ann. Report of Peabody Museum, Boston, 1872, page 22 sqq.

2) fruit; berry found in the woods.

hororo red owl.

Hostaqua or Hustaca, nom. pr. of an Indian settlement and its chief, on an affluent of St. John's River.

iarua sorcerer, conjurer (De Laud.). This epithet given to the Timucua shamans refers to their prophetic power and the convulsions affected by them to obtain oracles of war; from yuru to tremble, to be shaken or contorted.

ichi cold; ibine-ichicosa to throw into cold water.

ichuqui to throw away, to spill.

inoni to work. Domingo equelemate inonibicho? did you do any work on Sunday?

inoso, inosobo to make work, to cause to work.

iquaso, iquase to cry forth, to utter a cry, to scream; iquaseti not to utter a cry. Cf. qi in hitiqiri.

Iracana, nom. pr. of a river falling into the Atlantic, probably in Georgia (De Laud.); also called Salinacani. The French called it "*la Somme*," or according to the map of De Bry, *l'Aisne* (Axona).

iriboso to flood something.

isi blood.

isito to bleed; ichinima isitoco to cause my nose to bleed.

itori alligator. These reptiles served as food to the Timucua people.

ituhunu prayer.

jufere a wicker basket for catching fish (Span. *nasa*).

yechino query, question.

yoqe, yoqua past, bygone. ano nayo holata yoqua former white governors.

yuquiso to lay, deposit on the side of.

yubueha, yubehe to transfix, pierce, strike. atulu chi yubeheti the arrow may pierce you.

yubuo, yubana sodomite.

Yupaha, nom. pr. of a town seen by Hernando de Soto's army. Contains paha "houses;" perhaps: Yoque paha, "Oldtown."

yuri, yuru to be shaken up, to tremble; to be angry.

iyorona (for yuruna) eel.

Maracu, in the French orthography Marracou, an inland camp of Indians. Seems to contain mero, melo *warm, hot.*

mela, mero hot, heated, boiling.

melasonolehabetile cuyuma: not to throw the fish into hot water.

nimaru to preserve one's heat.

meleni petticoat; probably made of bulrushes of the salt marsh (cf. melo).

meleniqi to put on a petticoat.

melo salt. ibini melo salt water; moca melo salt sea; hono-melo ocean

shell. Probably identical with mela, mera hot, warm, the temperature of the sea water forming a contrast with that of fresh-water springs in southern latitudes.

mine winter; minama in winter-time, during the wintry season; viz. first (mine) of year.

miso old, aged; older than. ano miso mareca six old men. ano misoma ituhute incantated by a conjurer.

mo to speak, say, tell.

mono, mueno to call by name, to name.

moso to make.

mani to consent, desire; manino to be hungry or thirsty.

manta, manda 1) to wish, desire; 2) sign of the future tense.

mota to agree, consent, declare; 2) a word, saying; 3) thus, so.

moqua, maqua to serve, attend to wait upon, cf. atimoqua; mine Diosi maqua to serve the great God.

nabe, every, each; nabe chaleque every morning; viz.: every new (day).

naboto to strike (for ni-aboto); said f. i. of the thunderbolt (numa-hebua).

nacu to drink; ninacu to ask for drinking.

nacunu contr. from na acu ano.

nayo (when standing for na eyo): another, any other.

naquila, ninaquilasi to perfume; from uque oil, grease.

nate (among other significations) or, or else, or either; acunate again.

Nia Cubacani, nom. pr. of a woman (De Laud.); probably: niaco pacano.

niponosi to return to somebody; from pona to come.

niponosihero-manda bohobi cho? did you believe that he would possibly return (to you)?

ofuenoma, afuenoma, ofonoma, 1) after, behind (temporal and local). ofuenoma Diosima: in preference to God, after God. hibate maytines ofonoma: after having said the morning mass; halifonoma nantela I call it to be against nature. 2) on the subject of, concerning, about something: caqi mandamiento ofuenoma yechino cantela, *or:* caqi mandamiento ofuenoma na-yechinoma cantecarela: all these are questions (or queries) concerning that commandment.

Olataraca, nom. pr. of the nephew of the chief Saturiwa (De Laud.). The first part of the name is holata, chief.

orobo, oroboni to cure, heal; to treat for sickness.

ch-orobonate you to be cured.

orobisi to correct, chastise. orobini to go to confession.

orobisiono advice, counsel; na orobisionoma (good) advice, intelligence; orobaso to bewitch. orobota incantation, witchcraft.

orobono glory (of heaven).

Patica, nom. pr. of a coast settlement or locality eight leagues from the French Fort St. Charles, on St. John's River. It lay a short distance south of the outlet of that river; the name is a compound of paha *houses*, and tico *canoe;* canoe-houses, cabins near a harbor.

pia, piaha to hide, cover up.

pile field; pilema numa hebuama nabotoqe when lightnings have struck the field.

hachipile animals; lit. "what is on the field."

purucusta to run. If paracusi is a derivative of this, it means "the chief of the war-expeditions."

samota 1) to bathe in; samota niyena to bathe in the juice of an herb; 2) a rubbing with, a bathing in.

Sarrauahi, also written Saranay, Serraney; nom. pr. of a river and of an Indian settlement located on its shores, north of the outlet of St. John's River.

Saturiwa, or, in French orthography, Satourioua, nom. pr. of a paracusi on St. John's River, mentioned by De Laudonnière. Lived on sea-coast, a short distance south of the outlet of St. John's River.

Seloy, nom. pr. of a river in the Timucua territory, interpreted by De Laudonnière par "la rivière des dauphins," Porpoise River.

sieroa pira red metal, *gold* (De Laud.).

suquoni to rub on, to rub oneself with; niye suquoni to rub oneself with the juice of herbs.

Tacatacuru, nom. pr. of a river falling into the Atlantic Ocean north of the St. John; contains taca *fire*, probably in a redoubled form. The French under De Laudonnière called this river *La Seine*.

tapaga tapola "little baskets of mill" (Hakluyt); a compound term; the latter word is holaba, tapolaba Indian corn and contains abo stalk, maize-plant.

toca "new fruit," tococo to eat that "new fruit."

toya name of a feast of the Timucua people (De Laud.).

tola laurel; Tolemaro a town near the outlet of the St. Mary's River, on Northern boundary of Florida; once inhabited by Timucua Indians. The name contains tola laurel.

ubua, uba 1) to enter, go into, as into the net. cuyuma ubuata qibe the first fish (plur.) caught; 2) to catch, get hold of.

uqua to eat, said of certain edibles only. tapolamano inti uquabi cho? did you eat the maize (-ears)? uquaso to eat, and to give to eat.

uque oil, grease; ara uque bear's grease.

uqui, huqe, rain; uquihe, uquisa, uquiso to produce rain.

A Mirror for Illuminating Opaque Objects for the Projecting Microscope.

By Persifor Frazer, Jr.

(*Read before the American Philosophical Society, Feb.* 20, 1880.)

The subject of the present note is an arrangement for representing opaque objects through the gas microscope, especially adapted to Zentmayer's 1½ inch objective. It is only claimed to be better than the parabolic reflector of Smith & Beck, J. Lawrence Smith, Sorby and others, where the working distance of the microscope is comparatively large (*i. e.*, the distance from the objective to the object on the stage is ½ inch or more) and for the purposes mentioned. Where the distance is as great as that just mentioned the dispersion of rays from the reflexion at one point, of rays from very different parts of the mirror, is so great that only a few rays from the upper part of the mirror reach the lens at all. It would be different with a lens having a very small working distance, and in this case a parabolic reflector would be preferable.

The apparatus consists of a brass tube made to slide over the lens, on the lower end of which is fixed a glass plate about 1 mm. in thickness so attached as to be capable of a sliding motion towards or away from the hinged mirror which is attached to the edge of the metal flange in which the glass plate slides. This simple contrivance permits the glass plate to be brought into close contact with the reflecting mirror no matter at what angle the latter may be placed.

The mirror is made of nickel-plated German silver neatly mounted on a small hinge.

The light is admitted from below through a diaphragm after the rays have been rendered parallel by the condenser of the lantern, the aperture of the diaphragm being adapted to the maximum thickness of beam which can be effective for illumination, and which (calling a the aperture of the lens and i the angle of incidence of the beam) $= a \cos i$: or for an aperture of $\frac{7}{8}''$ ($= 0.875''$) and an incident angle of 62°, $0.411''$ or roughly $0.4''$.

The less the incident angle of course the larger the beam of light will be, and the greater diameter of the diaphragm. The refractive index of the glass employed to make the plate being 1.5, in order that the critical angle 41° 48′ may not be exceeded in the refracted ray, this angle of incidence or i must not be less than 61° 51′ or roughly 62°.

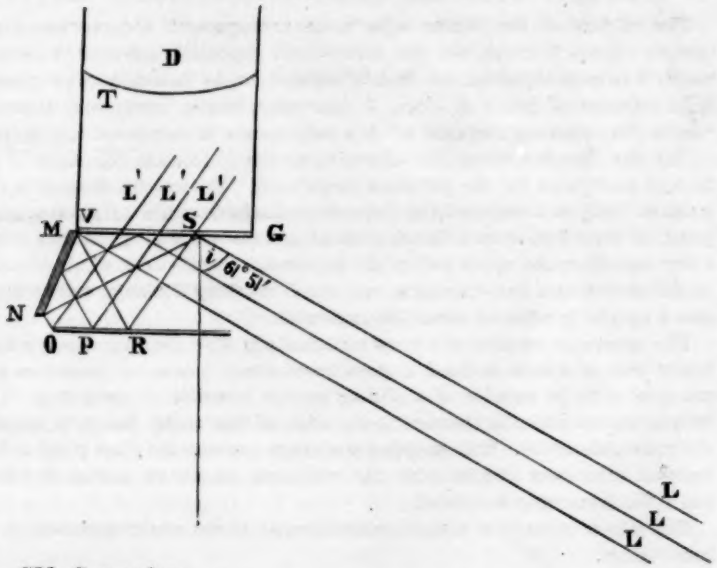
This minimum value of i determines the area of surface which can be illuminated on the microscope stage, but by altering the angle of the mirror very slightly all parts of the object may be successively projected on the screen. This minimum value is easily obtained from the critical angle of the glass employed, which is 41° 48′. The complement of this, or 48° 12′, is equal to the angle of refraction (or r) when the minimum value of i is attained.

$$\frac{\sin i}{\sin r} = 1.5$$

$$\sin i = 1.5 \ (\sin 48° 12')$$

$$i = 61° 51'.$$

In other words, the angle between the luminous ray and the glass plate can never exceed 28° 09′, or in round numbers 28°.



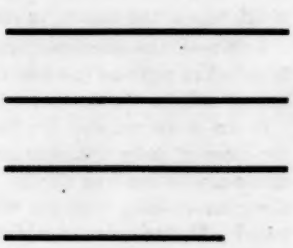
GM. Cover glass.
MN. Reflecting mirror.
OPR. Reflexion on object.
L′L′. Rays which pass through the objective.
D. Lens.
T. Sliding tube carrying reflecting mirror.
Angle of incidence 62°.

Three Methods and Forty-Eight Solutions of the Fifteen Problem. By Persifor Frazer, Jr.

(*Read before the American Philosophical Society, March* 5, 1880.)

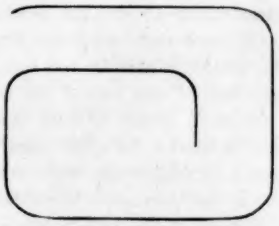
First Method.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	



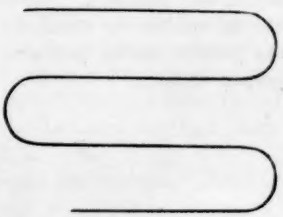
Second Method.

1	2	3	4
12	13	14	5
11		15	6
10	9	8	7



Third Method.

1	2	3	4
8	7	6	5
9	10	11	12
	15	14	13



PROC. AMER. PHILOS. SOC. XVIII. 105. 3M. PRINTED MARCH 29, 1880.

The requirements of the popular Fifteen Puzzle are to "move the blocks until in regular order." This regular order may be of three kinds, when the numbers are in consecutive series and the blank space is left either at the beginning or the end :

1. That usually understood where the numbers follow each other in broken lines like reading matter in type, or in the opposite direction.

2. Where the numbers follow a single coil from some point on the edge of the box to the centre, or *vice versa*.

3. Where the numbers follow a zigzag course across the box, reading from left to right on the first and third lines, and from right to left on the second and fourth, or *vice versa*.

It can be shown that the three conditions which render possible one or the other of these solutions are : 1st, the number which heads the outside column, whether 1 or 15 ; 2d, the direction in which the numbers increase along the outside, whether with or against the motion of the hands of a watch ; 3d, the order in which the four middle numbers occur.

Note. The direction of the motion of the column itself must always be such that the head does not move to a square just vacated by one of the series of which it is the first or last member.

There are sixteen possible solutions under each of the three methods, eight of them applicable to cases where 1 is at the head, and eight to cases where 15 is at the head.

Of these eight solutions four only are possible in any given position of the middle blocks in the box, the other four becoming possible when the positions of any two of the middle blocks are exchanged.

Of each group of four possible solutions in any given position of the middle blocks, two are possible when the outside column of numbers increase in magnitude with the motion of the hands of a watch, and two when the increase is the reverse of this.

Finally of the two possible solutions where the outside numbers are in arithmetical series and the position of the middle blocks is given, one brings the head of the outside column to a given corner, and the other to the diametrically opposite corner.

The middle numbers must always be the lowest four or the highest four.

The following four tables comprise all possible groupings of these two sets of four numbers. The dots in the small squares indicate by their number the method by which the solution can be obtained without disturbing the middle blocks, provided the outside numbers have been put in the proper order :

TABLE I.

	1.	2.	3.
a	12 15 14 13	12 14 13 15	12 13 15 14
b	13 14 15 12	13 12 14 15	13 15 12 14
c	14 15 13 12	14 13 12 15	14 12 15 13
d	15 14 12 13	15 13 14 12	15 12 13 14

TABLE II.

	1.	2.	3.
a	12 15 13 14	12 13 14 15	12 14 15 13
b	13 12 15 14	13 15 14 12	13 14 12 15
c	14 12 13 15	14 13 15 12	14 15 12 13
d	15 12 14 13	15 14 13 12	15 13 12 14

TABLE III.

	1.	2.	3.
a	1 4 3 2	1 3 2 4	1 2 4 3
b	2 4 1 3	2 1 3 4	2 3 4 1
c	3 2 1 4	3 1 4 2	3 4 2 1
d	4 3 1 2	4 1 2 3	4 2 3 1

TABLE IV.

	1.	2.	3.
a	1 2 3 4	1 3 4 2	1 4 2 3
b	2 4 3 1	2 3 1 4	2 1 4 3
c	3 2 4 1	3 4 1 2	3 1 2 4
d	4 2 1 3	4 1 3 2	4 3 2 1

No combination in any one of these pairs of Tables can be shifted to any combination in the other of the same pair (while the outside numbers remain in proper order) without lifting out of the box and transposing two of the numbers; but any combination can be shifted into any other in the same table by temporarily placing one number in the outer row and shifting the positions of the other three once, or twice.

Tables I and II are for all cases where 1 heads the column, Table III and IV are for cases when 15 heads the column.

In the first and third methods the box is turned till the first four numbers fall on the top line, or the last four on the lower line.

FIRST METHOD.

Arrangement of numbers in consecutive lines reaching from left to right or from right to left.

Number one heads the column of outside numbers.

Solutions only possible when 12 and 13 are *diagonally* adjacent. The motion of the head of the column must be past 15–12 in the order named, the 1 stopping on the square diagonally adjacent to that occupied by 12. Only those combinations permit solution when the 12 and 13 are *diagonally* adjacent. After the first row is complete, the 5 with its following series pass on the next line pushing the 15–12 before them, and the 9 and following three numbers pass on the third line pushing the 13–14 before them. When this third row is complete the numbers are in order. If after the outside series is complete the middle numbers occur as in any of the combinations of Table I (which are resolvable into each other by moving one of the blocks temporarily to the vacant space on the outside, rotating the others and then replacing it and if necessary repeating the operation by thus temporarily moving one of the blocks which is in its right place and rotating again till the desired combination is effected) the following solutions are possible:

I. *The middle numbers occur as in some combination of Table I.*

1. The increase of outside numbers is with the motion of the hands of a watch; a 1, and b 1 (turn box half round).
2. The increase of outsiders is opposite to the above; c 2, and d 3.

II. *The middle numbers occur in some combination of Table II.*

1. Increase of outside numbers with motion of watch hands c 1, and d 3.
2. Increase of outside numbers opposite to motion of watch hands a 3 and b 2.

Number fifteen heads the column of outside numbers.

Solutions are only possible when the 4 and 3 are *diagonally* adjacent. The 15 passes the 1 and 4 in this order and stops at the square diagonally adjacent to the 4. The 11 passes to the next line pushing the 1–4 before it; the 7 to the third line pushing the 3–2, and when this line is filled the numbers are arranged.

III. *The middle numbers are one of the combinations of Table III.*

1. The decrease of outside numbers with motion of watch hands, c 1 and d 2.
2. The decrease of outside numbers against motion of watch hands, b 3 and a 1.

IV. *The middle numbers are some combination of Table IV.*

1. Decrease of outsiders with motion of watch hands, a 2 and b 1.
2. Decrease of outsiders against motion of watch hands, c 3 and d 1.

Second Method.

Number one heads the outside column.

Solutions only possible when 12 and 14 of the middle numbers are *diagonally* adjacent. Bring the 11 alongside of the 12.

I. *The middle numbers occur as some combination of Table I.*
   1. The increase of outside numbers with motion of watch hands; a 3, and c 1.
   2. Increase of outside numbers against motion of watch hands; d 1, and b 2.

II. *The middle numbers some combination of Table II.*
   1. Increase of outside numbers with motion of watch hands; b 3, and d 1.
   2. Increase of outside numbers against motion of watch hands; c 2, and a 1.

Number fifteen leads. Solutions only possible when 1 and 3 are *diagonally* adjacent.

Bring the 5 alongside the 4.

III. *The middle numbers occur as some combination of Table III.*
   1. Decrease of outside numbers with motion of watch hands; b 2, and d 1.
   2. Decrease of outside numbers against motion of watch hands; a 3, and c 3.

IV. *Middle numbers occur as some combination of Table IV.*
   1. Decrease of outside numbers with motion of watch hands; a 3, and c 1.
   2. Decrease of outside numbers against motion of watch hands; b 2, and d 2.

Third Method.

The numbers read from left to right on the first and third lines and from right to left on the second and fourth, or *vice versa*, thus:

1	2	3	4
8	7	6	5
9	10	11	12
	15	14	13

The order of outside numbers is 1, 2, 3, 4, 8, 7, 6, 5, 9, 10, 11.

Solutions are only possible when 12 and 15 or 1 and 4 are diagonally adjacent. The first four numbers pass 13–12 in I and II, and 3–4 in III and IV, in the order named, the head of the column coming to rest at the square diagonally adjacent to the 12 or the 4 respectively.

Number one heads the column. The upper line is full.

I. *The middle numbers a combination of Table II.*
   1. First four numbers increase with motion of watch hands; a 2, and d 2.
   2. First four numbers increase against motion of watch hands; b 1, and c 3.

II. *Middle numbers a combination of Table I.*

1. First four numbers increase with motion of watch hands ; b 3, and c 3.
2. First four numbers increase against motion of watch hands ; a 2, and d 2.

Number fifteen heads the column. Order of outsiders, 15, 14, 13, 12, 8, 9, 10, 11, 7, 6, 5.

III. *Middle numbers a combination of Table IV.*

1. Last four numbers decrease with motion of watch hands ; a 1, and d 3.
2. Last four numbers decrease against motion of watch hands ; b 3, and c 2.

IV. *Middle numbers a combination of Table III.*

1. Last four numbers decrease with motion of watch hands ; b 1, and c 2.
2. Last four numbers decrease against motion of watch hands ; d 3, and a 2.

It is thus seen that there are four tables, each containing twelve combinations of the middle numbers or 48 combinations in all. Each of the three methods of solution takes four combinations from each table or one from every horizontal line, and no combination will permit of but one solution. Since these are all the possible combinations and a solution is given for every one it follows that no other solutions are possible than those above given.

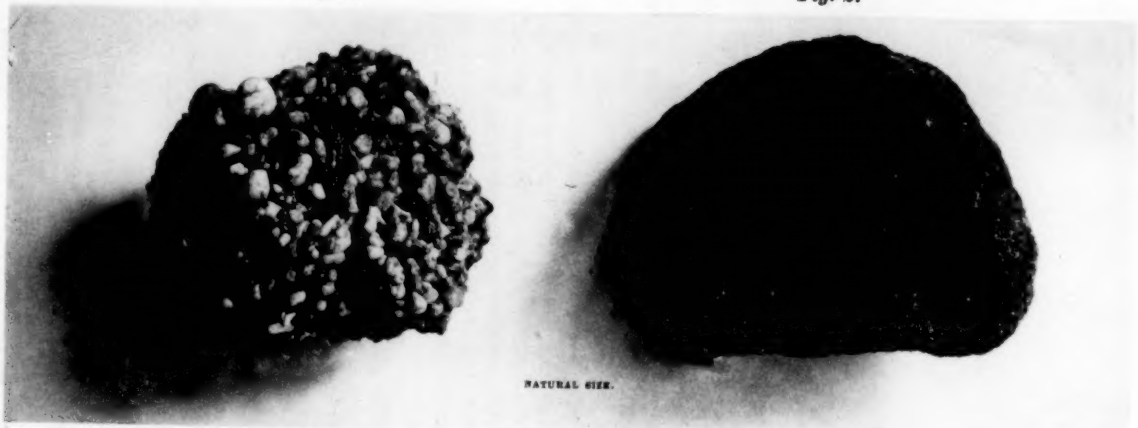
It is but just to say that the first demonstration of the possible solutions of the first method was printed by me in the *Bulletin* of Feb. 26 ; showing that in the 13, 15, 14 difficulty position, two solutions were possible, but that the box must be turned if the 1 was to occupy the left hand upper square. Afterwards a paraphrase of this was printed in the New York *Herald* of Feb. 28, without credit.

Erratum on page 258, 3d line from bottom. For 1000 meters read 1000 feet.

R. RATHBUN.

TO ILLUSTRATE A PAPER
ON THE
CONSTITUTION OF THE BRADFORD OIL SAND,
BY
CHAS. A. ASHBURNER. M. S.

Fig. 1. *Fig. 2.*



THIRD OIL SAND,
OIL CREEK, VENANGO COUNTY;

BRADFORD OIL SAND,
KENDALL CREEK, McKEAN COUNTY;

PENNSYLVANIA.

Phototype. F. Gutekunst. Philadelphia.